2002-2003
KINGS RIVER FISHERIES MANAGEMENT PROGRAM
ANNUAL TECHNICAL REPORT

Prepared by
Technical Steering Committee

Randy Kelly (member)
Stan Stephens (alternate)
CALIFORNIA DEPARTMENT OF FISH AND GAME

Jeff Halstead (member)
Dawn Carlton (alternate)
KINGS RIVER CONSERVATION DISTRICT

Steve Haugen (member)
Dr. Chuck Hanson (science advisor to the Association)
KINGS RIVER WATER ASSOCIATION

April 2004

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **viii**

ACKNOWLEDGEMENTS ..... **xx**

1.0 INTRODUCTION **1-1**
1.1 Administrative Activities 1-3
1.2 Annual Technical Report 1-3

2.0 HYDROLOGY AND OPERATIONS **2-1**
2.1 Reservoir Inflow 2-1
2.2 Reservoir Storage 2-2
2.3 Reservoir Releases 2-2
2.4 Telemetry System 2-5
2.5 Turbine Bypass Project 2-6
2.6 Exhibit C and D Flows 2-7
2.7 Summary and Discussion 2-8

3.0 WATER QUALITY **3-1**
3.1 Water Temperature Monitoring 3-1
3.1.1 Reservoir 3-1
3.1.2 River 3-3
3.2 Dissolved Oxygen Monitoring 3-7
3.2.1 Reservoir 3-7
3.2.2 River 3-7
3.3 Compliance with Dissolved Oxygen Requirements 3-8
3.4 Planning for Warm Water Temperature Event 3-10
3.5 Summary and Discussion 3-14

4.0 HABITAT ENHANCEMENT **4-1**
4.1 River 4-1
4.1.1 Introduction 4-1
4.1.2 Project Permitting 4-1
4.1.3 Boulder Placement 4-2
4.1.4 Construction of Coves and Jetties 4-6
4.1.5 Channel Ripping 4-9
4.1.6 Addition of Spawning Gravel 4-11
4.1.7 Thorburn Spawning and Rearing Channel 4-13
4.1.8 Fish Passage Evaluation 4-15
4.1.9 Investigation into Gifts and Grant Opportunities 4-15
4.1.10 Advanced Planning and Project Scoping 4-16
4.1.11 River Habitat Typing Report and Map 4-16
4.1.12 Aerial Photography 4-19

TABLE OF CONTENTS (continued)

4.2 Pine Flat Reservoir 4-20
4.2.1 Grass Seeding 4-20
4.2.1.1 Annual Grasses 4-20
4.2.1.2 Perennial Grasses 4-27
4.2.2 Seed Collection for Nursery Stock 4-28
4.2.3 Adding fish habitat to Pine Flat Reservoir 4-29
4.3 Summary and Discussion 4-31

5.0 FISH STOCKING 5-1
5.1 Introduction 5-1
5.2 River 5-1
5.2.1 Whitlock Vibert Boxes 5-1
5.2.2 Streamside Incubators 5-1
5.2.3 Trout Stocking 5-8
5.2.3.1 Subadult Trout 5-8
5.2.3.2 Catchable-sized Trout 5-9
5.2.4 Supplemental Trout Stocking 5-9
5.2.5 Collecting and Planting Eggs from Wild Trout 5-10
5.3 Reservoir 5-11
5.3.1 Kokanee Salmon 5-11
5.3.2 Catchable-sized Trout 5-11
5.3.3 Chinook Salmon 5-11
5.3.4 Florida Strain Largemouth Bass 5-11
5.3.5 Florida Strain Bluegill 5-11
5.4 Summary and Discussion 5-13

6.0 MONITORING 6-1
6.1 Introduction 6-1
6.2 River 6-1
6.2.1 Annual Fish Population Surveys 6-1
6.2.2 Coves and Jetties Monitoring 6-2
6.2.3 Boulder Clusters and Channel Ripping 6-9
6.2.4 Thorburn Spawning Channel 6-10
6.2.5 Spawning Gravel Placement Monitoring 6-12
6.2.6 Macroinvertebrate Survey 6-13
6.2.7 Algal Die-Off 6-24
6.2.8 Trout Tagging Studies 6-24
6.2.9 Angler Logbooks 6-27
6.3 Reservoir 6-31
6.3.1 Gill Netting 6-31

TABLE OF CONTENTS (continued)

6.3.2 Boat Electrofishing 6-31
6.3.3 Bass Tournament Results 6-32
6.3.4 Angler Creel Census 6-34
6.4 Summary and Discussion 6-36

7.0 PUBLIC EDUCATION AND OUTREACH 7-1
7.1 Introduction 7-1
7.2 Angling Regulation Changes 7-1
7.3 Public Education and Outreach Signs 7-2
7.4 Summer Hydrology and Temperature Reports 7-4
7.5 Web Page Development 7-4
7.6 News Releases and Newsletters 7-4
7.7 Angler Access Improvement (Greenbelt Parkway) 7-4
7.8 Miscellaneous 7-5

8.0 DEVELOPMENT OF 5-YEAR PLAN 8-1

9.0 REFERENCES 9-1

10.0 APPENDICES A-1
10.1 APPENDIX A – Tabular summary of daily inflow into Pine Flat Reservoir, Daily water releases from Pine Flat Dam, and daily flow measured at Fresno Weir October 1999 – May 2003 ..... A-1
10.2 APPENDIX B – Monthly vertical reservoir temperature and dissolved oxygen profile measurements at Pine Flat Reservoir May 2002 through May 2003……... B-1
10.3 APPENDIX C – Daily water temperature monitoring at each of the individual outlet ports on Pine Flat Dam C-1
10.4 APPENDIX D – Results of water temperature monitoring at permanent locations other than ACOE Bridge and FresnoWeir D-1
10.5 APPENDIX E – Draft Supplemental Fish Stocking Element E-1
10.6 APPENDIX F - Draft study plan for monitoring of the Thorburn Spawning and Rearing Channel Gravel Project F-1
10.7 APPENDIX G – News Releases G-1

LIST OF TABLES AND FIGURES

TABLE **Page**

2-1 Annual Runoff in thousands of acre-feet (TAF) and percent water year from October 1999 through September 2003 2-2
2-2 Exhibit C and flows (cfs) from the Framework Agreement 2-7
3-1 Minimum, maximum and mean daily dissolved oxygen level at the ACOE Bridge from May 2002 through May 2003 3-8
3-2 Comparison of average daily water temperatures at ACOE Bridge and Fresno Weir during September-November, 2002 3-14
4-1 Summary of permits obtained lower Kings River habitat enhancement projects 4-2
6-1 Summary of pre- and post-electrofishing survey of coves and jetties and control sites 6-7
6-2 Fish observed in the Thorburn Spawning and Rearing Channel during Electrofishing December 2, 2002 6-11
6-3 Summary of 2003 macroinvertebrate sampling sites 6-15
6-4 Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate community at sampling reaches 6-17
6-5 Kings River benthic macroinvertebrate survey results 6-18
6-6 Comparison of the EPT and CRAP indexes for macroivertebrate samples collected from the lower Kings River in 2003 6-21
6-7 Comparison of the number of taxa found between Burdick 1974 study and the FMP 2003 study 6-23
6-8 Comparison of the EPT and CRAP indices for the Burdick study 6-23
6-9 Summary of catchable trout tagging study 6-26
6-10 Summary of trout reported to be caught from angler logbooks between 2000 and 2003 within the lower Kings River 6-30
6-11 Summary of organized bass tournaments at Pine Flat Reservoir 2000 through 2003 (incomplete data in 2003) 6-33
6-12 Summary of angler effort and catch rate at Pine Flat Reservoir for the period July 1999 though June 2003 as determine by an occasional roving creel survey 6-35

FIGURE **Page**

1-1 Map of lower Kings River and key geographic reference locations 1-5
2-1 Daily inflow into Pine Flat Reservoir between October 1, 1999 and May 30, 2003 2-1
2-2 Daily storage volume in Pine Flat Reservoir from October 1999 to May 2003 2-3
2-3 Average daily water releases from Pine Flat Reservoir to the lower Kings River between May 1999 and May 2003 2-3
2-4 Measured average daily flows in the Kings River below Fresno Weir from October 1999 through May 2003 2-4

FIGURE(Continued) **Page**

2-5 Example of the remote temperature and flow monitoring data at Fresno Weir 2-5
2-6 Construction of the Turbine Bypass Project 2-6
2-7 Completed Turbine Bypass Project, March 2003 2-6
3-1 May 2002 vertical reservoir temperature and dissolved oxygen profile measurements at Pine Flat Reservoir 3-2
3-2 Permanent water temperature monitoring locations on the lower Kings River 3-4
3-3 Water temperature monitoring at the Army Corps Bridge and Fresno Weir, May 2002 - May 2003 3-6
3-4 Monitoring station on the ACOE Bridge 3-7
3-5 Dissolved oxygen concentration measurements at the Army Corps Bridge from May 2002 through May 2003 3-9
3-6 Comparative analysis of water temperature measured at the Army Corps Bridge and Fresno Weir 3-12
3-7 Increasing (September 15) and decreasing (November 1) trends in water temperature as a function of distance downstream of Pine Flat Dam 3-13
4-1 Map showing location of habitat improvement projects on the Lower Kings River 4-3
4-2 Boulder placement sites on the lower Kings River 4-4
4-3 Placement of boulders in the lower Kings River 4-5
4-4 Completed boulder project near Winton Park 4-5
4-5 Cove and jetty projects on the lower Kings River 4-7
4-6 Construction of cobble jetties in the lower Kings River 4-8
4-7 Completed coves and jetties near the Pine Flat Recreation area 4-8
4-8 Channel ripping of the lower Kings River 4-9
4-9 Completed channel ripping project near Winton Park 4-9
4-10 Channel ripping sites in the lower Kings River 4-10
4-11 Placement of spawning gravel in the lower Kings River 4-11
4-12 Completed spawning gravel placement project near the Army Corp Bridge 4-11
4-13 Gravel placement projects on the lower Kings River 4-12
4-14 California Conservation Corps members installing drip irrigation system to irrigate newly planted trees 4-13
4-15 California Conservation Corp placing protective cage around newly planted tree 4-13
4-16 Jack Thorburn with Tenaya Middle School students preparing to install wood duck nest boxes 4-14
4-17 Completed cobble wing deflector in the Thorburn Spawning Channel 4-14
4-18 Map of the Pine Flat Reservoir showing the location of habitat improvement projects 4-21
4-19 Deer Creek study area 4-22
4-20 Deer Creek planting station showing the area receiving the timed release fertilizer location to the left of center 4-22
4-21 Island Park winter wheat planting area 4-24

FIGURE(Continued) **Page**

4-22 CCC providing soil preparation at Island Park seeding area 4-24
4-23 Winter wheat beginning to emerge after a two-week period highlighted by good rains in March 4-25
4-24 Winter wheat emerging with a small amount of Bermuda grass in a slightly eroded area 4-25
4-25 A view from Island Park 4-26
4-26 Heavily eroded area at Island Park launch ramp which was planted for a second year with Bermuda grass 4-27
4-27 Common vetch intertwining with lotus plants 4-28
4-28 The bush lupine *Lupinus* sp., which grew well in laboratory testing 4-29
4-29 Construction of gabions at Sycamore Canyon campground 4-30
4-30 Manzanita filled gabions being readied for transport to Sycamore Cove 4-30
5-1 Whitlock Vibert box being charged with eyed trout eggs… 5-3
5-2 Early version of streamside incubator 5-3
5-3 Map of temporary streamside incubator locations 5-5
5-4 Streamside incubator showing baffles and thousands of newly hatched trout fry 5-6
5-5 Members of the PAG digging artificial redds for placement of trout eggs in the river 5-6
5-6 Permanent streamside incubator locations 5-7
5-7 Tagging procedure applied before introducing Florida strain bluegill into Pine Flat Reservoir 5-12
6-1 Electrofishing survey to determine trends in fish populations 6-2
6-2 Map showing electrofishing stations 6-3
6-3 Trend in number of wild trout captured during annual fish surveys over the last twenty years 6-4
6-4 Macroinvertebrate sampling sites 6-22
6-5 Summary of trout tagging studies 6-27
6-6 Example page from the angler logbook 6-29
6-7 Length-frequency of trout reported caught in angler logbooks between 2000 and 2002 from the lower Kings River 6-30
6-8 Species composition found during boat electrofishing surveys of Pine Flat Reservoir 6-32
6-9 Fish species composition based on angler interviews at Pine Flat Reservoir 6-35
7-1 Angling regulation signed installed by members of the PAG along the lower Kings River 7-3
7-2 Project sign being installed by PAG members at the Thorburn Channel 7-3
7-3 Mickey Powell and Tim O'Halloran at the Fresno Flyfishers for Conservation Banquet 7-5

EXECUTIVE SUMMARY

The Kings River Water Association (KRWA), Kings River Conservation District (KRCD), and California Department of Fish and Game (CDFG) have jointly implemented habitat enhancement projects, fish stocking, conducted a series of monitoring programs in the lower Kings River and Pine Flat Reservoir, and actively pursued public education and outreach activities over the past four years in response to the Kings River Fisheries Management Program (FMP) Framework Agreement, which was approved on May 28, 1999. The Framework Agreement includes a number of actions designed to protect and enhance fishery habitat within the lower Kings River and reservoir. The Technical Steering Committee (TSC) is responsible for implementing the actions authorized under the agreement and approved by the Executive Committee (ExCom). The scope of activities undertaken as part of the fishery program between May 2002 and May 2003 described in this technical synthesis report includes:

- Habitat enhancement projects including boulder placement, construction of coves and jetties, channel ripping, spawning gravel augmentation, Thorburn Spawning and Rearing channel enhancement, fish passage evaluation, river habitat typing, and identification of grant opportunities. In addition, enhancement projects have been conducted within Pine Flat Reservoir including grass seeding, planting small bushes and trees, and anchoring manzanita filled gabions to provide cover habitat for warmwater fish inhabiting the reservoir;

- Fish stocking in the lower river included Whitlock-Vibert Box egg incubation, streamside egg incubators for rainbow trout (*Oncorhynchus mykiss*), routine stocking of sub adult and catchable size rainbow trout, and supplemental catchable trout stocking. Fish stocking in Pine Flat Reservoir included kokanee salmon (*O. nerka*), Chinook salmon (*O. tshawytscha*), catchable size rainbow trout, Florida strain largemouth bass (*Micropterus salmoides*), and Florida strain bluegill (*Lepomis macrochirus purpurescens*);

- Monitoring hydrology and operations including inflow to Pine Flat Reservoir, reservoir storage, reservoir releases, installation and operation of remote sensing telemetry systems, turbine bypass project construction and operation, and activities to implement enhanced winter flows for fishery habitat as outlined in Exhibits C and D of the framework agreement;

- Monitoring water temperature and dissolved oxygen within Pine Flat Reservoir and the lower Kings River, compliance with dissolved oxygen requirements within the lower river, and planning and monitoring water temperature conditions at the completion of the irrigation season;

- Monitoring activities associated with the fishery program included electrofishing surveys within the lower river to develop annual fish population indices, monitoring of fish use within areas associated habitat enhancement projects such as coves and jetties, monitoring within the Thorburn spawning channel, spawning gravel

placement, macroinvertebrate surveys, catchable trout mark-recapture tagging studies, and angler logbooks. Monitoring within Pine Flat Reservoir included gill netting, boat electroshocking, compilation of bass tournament records, and angler creel census;

- Public education and outreach included modification of angling regulations, public education and angling regulation signs, summer hydrology and water temperature monitoring reports, internet web page development, news releases and newsletters, and angler access improvements; and

- Development of a 5-Year Plan for identifying specific habitat enhancement and monitoring projects to be completed as part of the fishery program each year on the lower Kings River and Pine Flat Reservoir.

This report presents a compilation and synthesis of information regarding habitat enhancements and monitoring activities during 2002-2003. Since the framework agreement has been in place since 1999, the technical compilation and synthesis report also presents information from earlier habitat enhancement projects and monitoring activities as part of the Framework Agreement. The technical report is designed to compile and summarize information available on the implementation and performance of the fishery program on the lower Kings River and to serve as a basis for subsequent annual monitoring reports that will convey information on the program to the ExCom, the Public Advisory Committee (PAG) and other interested parties. Results of the fishery and habitat monitoring program are intended to provide a technical and scientific framework for identifying design criteria and priorities for determining the appropriate scale and location of future habitat enhancement projects, linkages among potential projects to maximize biological benefits and reduce cost, and identify potential opportunities from expanding enhancement projects through funding augmentation from collaborative grant applications for state, federal, and private funding sources. This technical report and subsequent annual reports are intended to accompany the 5-Year Implementation Plans to describe and document results of the fishery program to date. The report will serve as the technical and scientific foundation for the identification of priority actions to be implemented as part of subsequent 5-Year Plans and/or to identify significant findings that would affect the fishery monitoring within Pine Flat Reservoir and the lower river or the identification of specific management actions designed to enhance and improve habitat conditions for resident trout and other fish species deemed desirable that inhabit the Kings River system.

In preparing the 2003 5-Year Plan a number of questions arose regarding the evaluation of the effectiveness of various habitat projects in meeting the biological goals of the program, the effectiveness of the existing monitoring program in evaluating performance of habitat enhancement, the status and trends of the river trout population, and concerns about water quality including the health and condition of aquatic algae and macroinvertebrates within the river. The following sections briefly describe key findings of the 2002-2003 fishery program and the associated assessment of program performance in meeting habitat enhancement priorities for the fishery communities inhabiting the Kings River.

Hydrology and Operations

Hydrologic conditions and Pine Flat Reservoir operations and flows within the lower river during 2002-2003 were characterized by high seasonal variability characteristic of the Kings River watershed and water supply operations. Findings and recommendations regarding hydrology and operations include:

- Pine Flat Reservoir operations were successful in maintaining the temperature control pool in the reservoir above the 100,000 acre-foot level specified in the Framework Agreement;

- Reservoir releases were characterized by relatively high stream flows during the irrigation season, which were substantially reduced during the non-irrigation season;

- Average daily streamflows, as measured at Fresno Weir, were in compliance with the Exhibit C minimum streamflow requirements contained in the Framework Agreement throughout the 2002-2003 water year;

- A real-time telemetry system has been installed and is providing information on water temperature and flow at Fresno Weir. This data is available for monitoring and managing conditions within the lower river as part of the fishery program;

- The turbine bypass project has been completed and is operational. The turbine bypass provides additional flexibility in managing the cold water pool within Pine Flat Reservoir and the temperature of water released into the lower river to support suitable habitat conditions for trout as part of the fishery program; and

- Planning activities were conducted by KRWA during 2002-2003 to establish a framework of agreements necessary to achieve Exhibit D flows by October 2005. The TSC supports the activities of the Exhibit D committee and a continued focus on establishing the framework agreements necessary to successfully implement Exhibit D flows as outlined in the Framework Agreement.

Water Quality Monitoring

Results of water quality monitoring within Pine Flat Reservoir and the lower Kings River during 2002-2003 have shown:

- Pine Flat Reservoir becomes stratified during late spring, summer, and fall showing a characteristic pattern of warmer water near the reservoir surface (epilimnion) and colder water with reduced dissolved oxygen concentrations near the bottom of the reservoir (hypolimnion). The reservoir destratifies in the late-fall and winter when water temperatures and dissolved oxygen concentrations become fairly uniform throughout the water column;

- The temperature of water released from the reservoir into the lower river can be regulated and managed, to some extent, through selective operation of different outflow works, including the turbine bypass, which initiated operations during 2003. However, the ability to manage water temperatures is limited and constrained by the availability of cold water during various seasonal periods within the reservoir, hydroelectric generation, requirements for irrigation releases, limited number of release points and other factors;

- Aeration and mixing of water released from the reservoir has proven to be effective in maintaining suitable dissolved oxygen concentrations within the lower river. Mean monthly dissolved oxygen concentrations, as measured at the Army Corps of Engineers (ACOE) Bridge, during 2002-2003 exceeded 7.0 mg/l, although minimum daily concentration were slightly lower than 7 mg/l on occasions during summer and fall months. Dissolved oxygen levels measured during 2002-2003 were within the range considered to provide suitable habitat conditions for trout and other fish and macroinvertebrates inhabiting the lower Kings River;

- Water temperatures within the lower river showed a seasonal pattern with the coldest temperatures occurring during the late winter and temperatures generally increasing during the summer and early fall;

- Water temperature showed a characteristic longitudinal gradient. The coldest temperatures occurred immediately downstream of Pine Flat Dam and increased, during summer months, with distance downstream from the dam. During the fall and winter, when atmospheric temperatures are cool, a reverse temperature gradient was observed with temperatures decreasing as a function of distance downstream from Pine Flat Dam;

- Water temperature within the lower river (to Fresno Weir) after completion of the 2002 irrigation season remained within a range considered to be capable of supporting trout, although potentially stressful within the lowermost reaches, to support juvenile and adult trout. Water temperatures started to decrease after approximately early-October making conditions more suitable for trout;

- Results of temperature monitoring, and results from the fishery monitoring program, provided no evidence that either dissolved oxygen concentrations or water temperature conditions within the lower river resulted in mortality to trout or other fish species during 2002-2003; and

- Results of the 2002-2003 water temperature and dissolved oxygen monitoring are being used by the TSC to refine water quality monitoring as part of the fishery program and as a basis for evaluating alternative operational strategies, including operations of the turbine bypass, to address water quality issues affecting habitat conditions for trout in the future.

Habitat Enhancement

The TSC is pleased with the 2002-2003 habitat improvement projects constructed in Pine Flat Reservoir and on the lower Kings River. The scientific literature supports the addition of spawning gravel, channel ripping, and addition of boulders to enhance habitat quality and availability for trout. These types of projects should be continued on an annual basis. Construction of coves and jetties is considered experimental and must be monitored for several years to determine if they are effective at providing habitat for young trout and other desired species before additional structures are built. Other habitat improvement techniques are continuing to be investigated by the TSC and their suitability for the lower river determined as part of the ongoing planning and development of priorities for inclusion in the 5-Year Plans.

The habitat improvement activities undertaken in the reservoir are well documented in the literature as effective tools for fishery improvement purposes (Durocher et al. 1984; Ploskey 1981). Habitat enhancement projects conducted within Pine Flat Reservoir, including grass seeding and construction of anchoring systems for additional cover habitat, provided promising results. Grass seeding within the reservoir inundation zone, planted during the late fall-winter, became well established and is thought to provide improved foraging and cover opportunities for juvenile fish during the spring when the vegetation is flooded by rising water. The addition of fertilizer proved to be successful in increasing the growth rate of grass planted in the reservoir with no observed negative impacts to water quality (J.Houk CDFG, personal communications). Additional investigation of perennial plant species for use in reservoir habitat enhancement is ongoing. Providing additional cover habitat for warmwater species has been identified by the TSC as being biologically beneficial and is recommended to continue as part of the fishery program. However, with the loss the CDFG Region 4 Reservoir Biologists position, it is unclear who will coordinate fishery work within the reservoir.

Based upon results of the 2002-2003 habitat enhancement projects, and preliminary results of visual observations and data collected, the TSC is supportive of continued habitat enhancement activities that would include, but not be limited to, the following:

- Grass seeding within the inundation zone of Pine Flat Reservoir;
- Investigations of potential perennial plant species that may improve habitat conditions within the reservoir;
- Continued construction of anchoring systems and cover habitat to benefit warmwater fish species at various water depths within the reservoir;
- Continued placement of boulders and jetty construction to provide cover and velocity refuges within the Kings River below Pine Flat Reservoir (lower river or lower Kings River);
- Continued gravel augmentation and channel ripping to improve gravel quality as habitat for trout spawning and macroinvertebrate production in the Kings River;

- Continued exploration of donations and grants to help support habitat enhancement activities, and augment funds available from the Framework Agreement, as part of the fishery program; and

- Monitoring the physical habitat characteristics and fish use of coves and jetties as part of the monitoring program. Based on the results of this monitoring, determine if the construction of additional coves and jetties is desirable.

Fish Stocking

Members of the TSC are pleased with the current rainbow trout stocking effort in the lower Kings River and anticipate no changes to the numbers or location at this time. The survival of young fish appears to be low. Adult trout produced from introduced eggs or subcatchable stocking appear to represent less than 1% of the adult population. We are not sure if this due to the strains of trout being used to produce the eggs incubated in the river as part of this program or, more likely, the absence of suitable habitat for juvenile, subadult, and adult trout within the lower river. As escape cover for young trout is improved, we hope that this results in improved survival. The TSC plans to continue to experiment with different strains of trout, including wild trout, in an effort to increase the size of the trout population.

Members of the TSC believe the monitoring results demonstrate that the fishery and current management at Pine Flat Reservoir is satisfactory and no changes should be made in current stocking practices. The TSC is continuing to evaluate the current and alternative stocking strategies for species such as bluegill within Pine Flat Reservoir.

Tests are being conducted and monitoring performed as part of the fishery program to further evaluate the survival and contribution of trout stocked at various life stages to the adult population in the lower Kings River. Based on monitoring results, it appears trout fry and subadult trout do not contribute significantly to the adult trout population. Furthermore, results of the tagging program demonstrate that harvest rates on catchable trout are moderate and that the abundance of catchable trout declines substantially within a relatively short period of time (weeks) after stocking within the lower river. Based on the available information, the TSC has recommended a strategy of continuing to stock catchable and subcatchable trout in the lower river, with the experimental augmentation of the egg incubators, under current conditions. As habitat conditions improve within the lower river, through implementation of habitat enhancement projects such as those conducted during 2002-2003, it is expected that in-river spawning and juvenile rearing will contribute more significantly to recruitment into the adult population. As habitat improves, the TSC currently anticipates considering a change in stocking strategies. This may result in a reduction in stocking catchable size trout (especially outside the put and take area) and an increased emphasis on stocking, and providing more favorable rearing conditions, for early life stages of trout.

Fishery and Habitat Monitoring

The 5-Year Plan identified fish population surveys within the lower Kings River after completing irrigation releases (December) and prior to initiating spring irrigation releases (March). The proposed fishery monitoring was designed to develop information on the carry over of trout during the low flow period. While the end of season monitoring occurred, the pre-irrigation monitoring did not. The December 2002 electrofishing results were similar to previous years, with low numbers of small trout captured at most sites. Very few of the marked trout were captured, indicating they are dieing, leaving the area, or not effectively sampled using current monitoring techniques. It is possible that the larger trout are in deeper water not available to sampling with backpack electrofishers. The fact the larger trout are reported in the angler logbooks and by PAG members and other recreational fisherman, although in relatively low numbers, supports this theory. Non-game fish continue to dominate the fish population in terms of both numbers and biomass. It appears that low recruitment of trout to the population continues to be a limiting factor for the fishery.

We conducted pre- and post-project monitoring on the coves and jetties project. The two trout captured at the Pine Flat Recreation site pre-project sampling were both captured from behind a large sycamore tree, which was providing instream habitat and cover. Young-of-the-year trout were observed and photographed by KRCD biologists using the coves and jetties in March 2003. We did not sample the construction site until late August 2003 and any trout would have most likely grown to an adequate size to seek deeper water. Future sampling needs to occur during the period from January through late- March to evaluated habitat use by juvenile trout within the coves and jetties. A number of nongame fish (e.g., Sacramento sucker, Sacramento pikeminnow, etc.) were collected during the post-project monitoring of the coves and jetties. Most of these fish were utilizing the upstream side of the jetties. However, the TSC has recommended that no additional coves and jetties be constructed until several years of evaluation have occurred.

Backpack electrofishers limit sampling to wadable water depth with low to moderate velocity. Often, trout seek the cover of deep pools during low flow periods. This deeper water has gone unsampled with the exception of angling by the public. We believe that the absence of sampling in deeper water habitats is largely responsible for the differences we see in monitoring results from backpack electrofishing and angler log book reports. Anglers are fishing these deeper waters. The TSC plans to conduct trout population monitoring using an electrofishing raft to survey deeper water habitats. Hopefully this will provide some insight into adult trout inhabiting deeper water, including areas adjacent to the boulder project.

During annual electrofishing surveys, trout are routinely collected from habitat associated with the boulder clusters. Our belief is that the boulder clusters provide very desirable habitat (e.g., cover habitat, velocity refuge, feeding stations, etc.) and the addition of boulder clusters to the river is recommended by the TSC as a continuing habitat enhancement activity.

The Thorburn spawning channel is functioning well as habitat for young trout. There are no indications that the channel is being used by adult trout for spawning. Non-trout fish species (e.g., Sacramento sucker, Sacramento pikeminnow, California roach (*Hesperoleucus symmetricus)*, Kern brook lamprey (*Lampetra hubbsi)*, threespine stickleback (*Gasterosteus*

aculeatus), and green sunfish (*Lepomis cyanellus)*) dominate the community inhabiting the channel. Survey results demonstrated that fish abundance increased within the channel as cover habitat increased. The TSC recommends that additional instream habitat and overhead cover be added to the channel. We hope to install half-logs or similar structures in the channel to provide desirable holding habitat for juvenile and adult trout.

Spawning gravel was added to the lower river during 2002-2003 in addition to stream channel ripping. These actions were intended to improve the quality and availability of gravel substrate for trout spawning in addition to improving conditions for macroinvertebrate production within the lower river. These habitat enhancement projects were located in areas where spawning activity was thought to occur and in areas adjacent to boulder projects where habitat would benefit juvenile trout rearing. As part of the project monitoring, the California Department of Water Resources (DWR) was contracted to survey habitat conditions and to assess gravel movement in response to irrigation flow releases. We do not have a final report from DWR yet, but this survey report will provide important information on the movement and longevity of the gravel in the lower river. The TSC plans to conduct spawning surveys within the gravel augmentation and ripping areas to see if the added gravel is being used by trout for spawning. Spawning surveys conducted in spring may be impaired by high flow conditions during irrigation releases.

Macroinvertebrate sampling was conducted at six locations within the lower river to provide information on the general taxonomic composition and diversity of macroinvertebrates. Results of the surveys showed that indicators of the macroinvertebrate community, although similar to other river systems, were characterized as fair and/or poor when compared to generic criteria developed from a composite of other streams and rivers. The macroinvertebrate study, if repeated in the future, would be improved by also sampling a control site (potentially located upstream of Pine Flat Reservoir) to provide a comparative basis for evaluating results of the macroinvertebrate collections within the lower river.

The TSC has developed and implemented a plan to address concerns regarding the algae die-off reported by anglers in 2003. The key to the success of this investigation into the cause and extent of the algal die-off is immediate reporting of the event by anglers to KRCD. In the past, we have learned of the die-off months after it is reported to have occurred.

During 2001-2002, catchable sized rainbow trout planted in the lower Kings River were tagged with $5 reward tags to estimate trout harvest rates by recreational anglers. The assumption is made that all tagged trout captured by anglers are returned. We know this is not correct and that some tags are kept or tagged fish are released. However, based on the results of this study, return rates ranged from 22.7% to 52.7% with a mean of 40% return. This means that of the trout planted in the lower Kings River during this period, approximately 40% of these trout were caught by anglers.

2002-2003 marked the third year of the use of angler logs books to monitor angler success. While this is a valuable tool, it needs to be energized in some fashion. We enjoyed good angler cooperation for the first two years, but by 2002 it was obvious that anglers were loosing enthusiasm with the reporting process. This program was initiated because anglers were

showing pictures of large trout they were catching on the lower river. These were trout not detected in the routine electrofishing surveys. The angler logbook reporting complements the electrofishing surveys and provides a valuable monitoring tool and important information on larger adult trout inhabiting the river. Results of the angler log book reporting showed that catch per angler hour has decreased from 0.76 trout per hour in 2000, to 0.53 trout per hour in 2001, 0.16 trout per hour in 2002 for an overall average catch of 0.55 trout per hour over the period from 2000 through 2002. The majority of trout ranged in length from 10 to 18 inches. If the angler logbook program is to continue, we need additional anglers to provide voluntary reporting using the log books.

We are pleased with the warmwater fishery at Pine Flat Reservoir and believe it is in good condition with an upward trend in both CPUE and size of bass being caught in the recreational and tournament fisheries. It is important to remember that each type of sampling gear has an inherent bias toward various parts of the fish populations and sampling results must be combined to get the best picture of the status of the fishery. Fishery sampling was conducted within Pine Flat Reservoir provides information on the relative abundance and species composition of fish inhabiting the reservoir. Gill netting within Pine Flat Reservoir found white catfish to be the most numerous species caught. Most of the sampling occurs in the open water environments and most centrarchids (bass and their relatives) are not as susceptible to gill nets. The results of electrofishing surveys show that largemouth bass (17%) and spotted bass (33%) comprise a significant part of the fish sampled. In addition, threadfin shad, a primary food source for bass, are also abundant. The food base is good, with 30% of the catch consisting of threadfin shad. The creel census again showed that spotted bass (42%) and rainbow trout (44%) comprised a large part of the anger creel. All this, combined with an upward trend in the catch per hour seen in bass tournaments, lead to the conclusion that this is a quality fishery. Habitat improvement efforts should continue in support of this fishery.

Rainbow trout are only seasonally available, so the data is slightly biased by time of year of the survey. The reaminder of the catch consisted of largemouth bass (8%), white catfish (3%), and bluegill (2%). Typical of most reservoirs, white catfish is an underutilized resource. It is also worth noting that the world record spotted bass was caught May 3, 2002 in Pine Flat Reservoir by Brian Shishido and weighed 10 pounds 4.3 ounces. Results of the available survey data support the finding that Pine Flat Reservoir supports a diverse recreational fishery that is comparable to other reservoir fisheries within the central valley.

Between 1985 and 1993, the average catch rate during bass tournaments was 0.191 bass per hour and the mean weight was 1.35 ponds (CDFG, unpublished data). The results from recent bass tournaments show a generally increasing trend (0.206 in 2000 to 0.326 in 2003) in catch per unit effort. The mean size of bass reported from tournament records from 2000 to 2003 also shows a general increasing trend in bass size (1.18 in 2000 to 1.7 pounds each in 2003). Results from recent tournaments indicate that both CPUE and bass size have shown an increase when compared to results from 1985-1993 records.

Public Education and Outreach

A significant measure of the success of the Kings River fishery program is active public involvement. The PAG has been actively meeting and engaging the TSC in discussions regarding the program as a whole, and the 5-Year Plan in particular, since adoption of the Framework Agreement. The PAG public education effort during 2002-2003 included (i) development of a web site, (ii) intra-group communications, and (iii) production and installation of educational signs along the lower river. Proposed changes to recreational angling regulations on the lower river designed to protect the fishery resource were also a focus of PAG activities during 2002-2003.

In an effort to protect trout that seem to have adapted to the physical conditions of the river (temperature and flow cycle) the TSC determined that changes in angling regulations were needed to provide additional protection for these adult trout. Angling regulations are under the authority of the California Fish and Game Commission and proposals have to follow their cycle for evaluating angling regulations. The TSC worked with members of the PAG to propose the needed changes to the Fish and Game Commission. A total of three angling regulation change proposals were forwarded by the PAG to the Commission in 2001 for adoption. All three of the proposed changes were approved and became effective March 1, 2002. They all remain in effect today.

During winter 2002, the Public Advisory Group, Fly Fishers for Conservation, and Kaweah Flyfishers posted angling regulation signs along the lower Kings River. River reaches posted include the catch-and-release zone from Cobbles Weir downstream to Highway 180, the special regulation zone from the ACOE Bridge to Pine Flat Dam, and the Thorburn Channel. A large 4 x 8 foot project sign was also posted at the Thorburn Channel to inform local landowners and visitors to the Kings River about the Fisheries Management Program habitat enhancement efforts.

KRWA has developed a real-time telemetry system for monitoring water temperature and streamflow at Fresno Weir. During the summer of 2003 information developed from monitoring being conducted on the lower Kings River was compiled in weekly reports and distributed by KRWA to members of the PAG and other interested parties to provide current information on environmental conditions occurring within the lower river that could affect habitat quality for trout. Weekly reports were distributed electronically and were used to inform managers and other interested parties regarding conditions occurring within the lower river. The water temperature and flow monitoring and reporting provided a valuable tool for disseminating real-time information. The TSC has recommended that the real-time monitoring and dissemination of weekly reports, when appropriate, be continued as part of the fishery program. In addition, the TSC recommends that information on current conditions occurring within the lower Kings River be developed in a format compatible with posting on an Internet based web page that would be accessible to the public.

The PAG has discussed the development and operation of a web page to inform the public, fishing groups, and government agencies about the Kings River fishery Management Program.

Also, the web page would present angling opportunities and information related to the Kings River. The web page has been started, but it is still under development. The web page is expected to be completed in 2004 – 2005.

During the May 2002 through May 2003 period, three news releases were made by the fishery program. The releases were sent to all major radio, news, and news paper sources, legislators, local government officials, and KRCD's mailing list of over 7,000 entities. The releases include (1) the gravel placement project – release dated September 30, 2002; (2) the channel ripping and coves and jetties projects – release dated October 7, 2002; and (3) the boulder placement project – release dated October 14, 2002. No newsletters of "Fishery News" were issued during the May 2002 through May 2003 period.

On June 6, 2002 the TSC and staff from KRCD, KRWA, U.S. Forest Service and local landowners conducted a field workshop on the Thorburn Spawning and Rearing Channel for the "Working at a Watershed Level" training course. Approximately 200 people attended the week-long workshop held at California State University, Fresno.

Mr. Tim O'Halloran, Water Master for the KRWA, and ExCom member, was awarded the Conservationist of the Year by the Fresno Fly Fishers for Conservation at their April 5, 2002 banquet. Mr. O'Halloran shared the honors with Mr. Mickey Powell, who received the same honor for his long and dedicated work to the lower Kings River fishery. Mr. Powell is past chairman of the PAG.

Development of the 5-Year Plan

The Framework Agreement includes elements addressing adaptive management (Section 1b); stream temperature monitoring (Section 1d); funding for habitat enhancement projects (Section 1f); enforcement, education, and awareness program (Section 1i); stocking program (Section 1j); development of criteria/monitoring (Section 1k); and access (Section 1p). Development of a 5-Year Plan is needed to provide guidance, prioritize activities and the allocation of expenditures, and coordinate among the parties to facilitate efficient implementation of these elements of the Framework Agreement.

A 5-Year Plan was developed during the 2002-2003 reporting period. This was the third annual modification to the 5-Year Plan since the signing of the Framework Agreement in May 28, 1999. Development of the 5-year work plan is based on a consideration of (1) specific requirements identified within the Framework Agreement; (2) results of previous fishery and water quality monitoring; and (3) prioritization of habitat restoration activities based upon limiting factors analyses. The 5-Year Plan: (1) provides a project management structure for reviewing and prioritizing proposed habitat enhancement activities, fish stocking, and other elements of the Framework Agreement; (2) identifies the objectives and methods to be used to assess the overall response of trout and other species for use in evaluating achievement of the Kings River aquatic resource goals as identified in Section 1a of the Framework Agreement; and (3) provides a framework for the experimental design and evaluation of specific enhancement activities (e.g., enhancement projects funded under the Framework Agreement, fish stocking and

supplementation, pulse flows for temperature management, etc.) within the context of the overall goals and activities being implemented through the Framework Agreement. Results of monitoring and evaluation activities serve, in part, as the basis for the adaptive management element of the Framework Agreement (Section 1b) and for identifying changes in program priorities, or the allocation of resources from one program element to another. The 5-Year Plan is a "living plan" that is reviewed by the TSC and ExCom on an annual basis throughout the 10-year period of the agreement and revised as projects and elements of the program are implemented and as new scientific information becomes available.

ACKNOWLEDGMENTS

The work detailed in this report has covered a large area of the Kings River and Pine Flat Reservoir, and crossed many ownership boundaries and involved numerous government agencies, property owners and individuals. It is the cooperation of these agencies and individuals that has allowed efforts to improve habitat and the aquatic resources of the lower Kings River to occur. The TSC would like to acknowledge the cooperation of the following agencies and individuals:

U.S. Army Corps of Engineers, Sacramento District, Regulatory Branch, Sacramento
(Mr. Mitch Hayden, Mr. Michael Jewell, Mr. Nancy Haley, Mr. Mat Hirkala)

U.S. Army Corps of Engineers, Sacramento District, Pine Flat Lake, Piedra
(Mr. Charles Parnell, Mr. Frank Fonseca, Ms. Sharon Anderson)

U. S. Fish and Wildlife Service, Sacramento Field Office, Sacramento
(Mr. Jacob Martin, Ms. Susan Jones)

U. S. Forest Service, Pacific Southwest Research Station, Forestry Sciences Laboratory, Fresno (Dr. Carolyn Hunsaker)

U. S. Natural Resources Conservation Service, Fresno
(Mr. Dave Durham, Ms. Karen Fullen, Mr. Kim Chang)

U. S. Bureau of Reclamation, Fresno
(Mr. Carl Daily)

County of Fresno, General Services Department, Parks Division, Fresno
(Mr. Charles Janiel)

Harris River Ranch, Piedra
(Mr. John Harris, Mr. Rod Radtke)

Jack and Margaret Thorburn, Sanger

Mr. Kent Kinney, Sanger

Ronald and Ester Butzlaff, Piedra

Kings River Fisheries Management Program, Public Advisory Group
(Members of the committee, especially Chairman Mr. Mickey Powell)

ACKNOWLEDGMENTS (con't.)

Kings River Conservation District, Fresno
(Executive Committee members Mr. Dave Orth and Mr. Lyn Garver, Board of Directors, management, and staff. Especially Mr. Patrick Campbell and Mr. Jerry Salazar as project managers for the Juvenile Trout Rearing Habitat Enhancement Project)

Kings River Water Association, Fresno
(Executive Committee members Mr. Tim O'Halloran and Mr. Steve Haugen, Board of Directors, management, and staff)

California Department of Fish and Game, Fresno
(Executive Committee members Mr. Bill Loudermilk and Mr. Dale Mitchell, management and staff, especially Mr. Brian Beal and Mr. Tracy Purpuro)

1.0 INTRODUCTION

The Kings River Water Association (KRWA), Kings River Conservation District (KRCD), and California Department of Fish and Game (CDFG) have jointly implemented habitat enhancement projects, enhanced the trout population, and conducted a series of monitoring programs in the lower Kings River (Figure 1-1) and Pine Flat Reservoir over the past four years in response to the Kings River Fisheries Management Program Framework Agreement, which was approved on May 28, 1999. The Framework Agreement includes a number of actions designed to protect and enhance fishery habitat within the lower Kings River and in Pine Flat Reservoir. The Technical Steering Committee (TSC) is responsible for implementing the actions authorized under the agreement and approved by the Executive Policy Committee (ExCom). The scope of activities undertaken as part of the fishery program between May 2002 and May 2003 described in this technical synthesis report includes:

- Monitoring hydrology and operations including inflow to Pine Flat Reservoir, reservoir storage, reservoir releases, installation and operation of remote sensing telemetry systems, turbine bypass project construction and operation, and activities to implement enhanced winter flows for fishery habitat as outlined in Exhibits C and D of the framework agreement;

- Monitoring water quality including water temperature monitoring within Pine Flat Reservoir and the lower Kings River, dissolved oxygen monitoring within Pine Flat Reservoir and the lower Kings River, compliance with dissolved oxygen requirements within the lower river, and planning and monitoring water temperature conditions at the completion of the irrigation season;

- Habitat enhancement projects including boulder placement, construction of coves and jetties, channel ripping, spawning gravel augmentation, Thorburn Spawning and Rearing channel enhancement, fish passage evaluation, river habitat typing, and identification of grant opportunities. In addition, enhancement projects have been conducted within Pine Flat Reservoir including grass seeding, planting small bushes and trees, and anchoring larger trees to provide cover habitat for warmwater fish inhabiting the reservoir;

- Fish stocking has occurred as part of the program within the lower river and Pine Flat Reservoir including Whitlock-Vibert box egg incubation, streamside egg incubators, routine stocking of subadult and catchable size trout, and supplemental catchable trout stocking, in addition to stocking within the reservoir including kokanee salmon, chinook salmon, catchable size trout, Florida strain largemouth bass, and Florida strain bluegill;

- Monitoring activities associate with the fishery program included electrofishing surveys within the lower river to develop annual fish population indices, monitoring of fish use within areas associated with habitat enhancement projects such as coves and jetties, monitoring within the Thorburn spawning channel, spawning gravel placement, macroinvertebrate surveys, catchable trout mark-recapture tagging studies,

and angler logbooks. Monitoring within Pine Flat Reservoir included gill netting, boat electroshocking, compilation of bass tournament records, and angler creel census;

- Public education and outreach included modification of angling regulations, public education and angling regulation signs, summer hydrology and water temperature monitoring reports, internet web page development, news releases and newsletters, and angler access improvements; and

- Development of a 5-Year Plan for identifying specific habitat enhancement and monitoring projects to be completed as part of the fishery program each year on the lower Kings River and Pine Flat Reservoir.

The following report presents a compilation and synthesis of information regarding these habitat enhancement, trout population enhancement, and monitoring activities during 2002-2003. Since the framework agreement has been in place since 1999, the technical compilation and synthesis report also presents information from earlier habitat enhancement projects and monitoring activities as part of the Framework Agreement. This technical report is designed to compile and summarize information available on the implementation and performance of the fishery program on the lower Kings River and to serve as a basis for subsequent annual reports that will convey information on the program to the ExCom, the Public Advisory Committee (PAG) and other interested parties. This technical report and subsequent annual reports are intended to accompany the 5-Year Implementation Plan to describe and document results of the fishery program to date and to serve as the technical and scientific foundation for the identification of priority actions to be implemented as part of subsequent 5-Year Plans and/or to identify significant findings that would affect the fishery monitoring within Pine Flat Reservoir and the lower river or the identification of specific management actions designed to enhance and improve habitat conditions for resident trout and other desirable fish species inhabiting the Kings River system.

One of the principle objectives of the technical synthesis report is to provide a project management structure for reviewing and prioritizing existing and proposed habitat enhancement activities, fish stocking, and implementation of other elements contained in the Framework Agreement. Results of the fishery and habitat monitoring program are intended to provide a technical and scientific framework for identifying design criteria and priorities for determining the appropriate scale of and location habitat enhancement projects, linkages among potential projects to maximize biological benefits and reduce cost, identify priorities for habitat enhancement project locations, and identify potential opportunities for expanding enhancement projects through funding augmentation from collaborative grant applications from state, federal, and private funding sources. In addition, one of the key objectives of the technical synthesis report is to help ensure coordination and communication among the parties involved in implementing various elements of the Framework Agreement, and to facilitate a process for reviewing and evaluating the performance of management actions in achieving the overall goals of the fishery program. The technical synthesis report also provides a framework to present monitoring results used by the TSC to evaluate a variety of alternative approaches each year for meeting the goals for the enhancement program, and for evaluating program performance.

The technical synthesis report presents results of the Kings River monitoring program used to evaluate specific enhancement activities (e.g., enhancement projects funded under the Framework Agreement, fish stocking and supplementation, etc.) within the context of the overall goals and activities being implemented through the Framework Agreement. Results of monitoring and evaluation activities serve, in part, as the basis for the adaptive management element of the Framework Agreement (Section 1b), and for identifying changes in program priorities, or the allocation of resources from one program element to another.

The TSC has prepared the 2002-2003 annual synthesis technical report as a companion to the 5-Year Plan that documents results of the monitoring studies and evaluation of current habitat enhancement actions. The annual technical report also serves as part of the scientific foundation for the programmatic program review being conducted by the TSC during 2003-2004.

In preparing the 2003 5-Year Plan a number of questions arose regarding the evaluation of the effectiveness of various habitat projects in meeting the biological goals of the program, the effectiveness of the existing monitoring program in evaluating performance of habitat enhancement and the status and trends of the river trout population, and concerns about water quality including the health and condition of aquatic algae and macroinvertebrates within the river. The following sections describe key elements and results of the fishery program and the associated assessment of the program performance in meeting habitat enhancement priorities for the fishery communities inhabiting the Kings River.

1.1 ADMINISTRATIVE ACTIVITIES

The Kings River Fisheries Management Program's third 5-Year Implementation Plan (for program year 2002-2003) was presented and accepted by the ExCom at a meeting held October 24, 2002. The 5-Year Plan provided the basic direction for the TSC and program activities through the year. The TSC met as a group on an ongoing basis (generally once a month) during the program year. Using the 5-Year Plan as a guide, the TSC focused their efforts on implementation of the various capital habitat enhancement projects approved by the ExCom, and the further development of the non-capital elements. There were nine capitol, five non-capitol and one maintenance element approved for implementation in the 2002-2003 5-Year Plan. The ExCom met four times (May 27, 2002; August 1, 2002; October 24, 2002; and March 27, 2003) to hear reports from the TSC, public, and Public Advisory Group, and to provide direction to the TSC.

Members of the TSC routinely attend the PAG meetings to report on their activities, provide input as requested, receive suggestions and answer questions.

1.2 ANNUAL TECHNICAL REPORT

A number of interested parties and stakeholders, including the ExCom, PAG, resource and water agencies, local angling groups, and others have expressed interest in the information being collected as part of the Kings River monitoring program. Preparation and distribution of an

annual technical documentation report has been identified as a useful method of conveying information regarding the program status and monitoring results to interested parties.

Fishery enhancement work under the guidance of the Framework Agreement has occurred on the lower Kings River and Pine Flat Reservoir since the signing of the Framework Agreement on May 28, 1999. This is the first annual report, which summarizes results of the habitat enhancement activities, trout stocking, and fishery and habitat monitoring between May 2002 and May 2003. Since this is the first technical synthesis report prepared under the Framework Agreement, data collected from earlier investigations is included in some instances to assess trends in the results.

The annual report summarizes key accomplishments and performance of the habitat enhancement actions and findings of the monitoring program. Compilation and analyses of available information used to assess performance of the Kings River fisheries management plan and habitat enhancement program is based upon results of both baseline monitoring within the Kings River and results of project-specific monitoring and performance evaluations. Information from a variety of program elements has been compiled each year representing results of each element of the Kings River monitoring program, as outlined in the 5-Year plan. The annual report includes an executive summary followed by brief descriptions of individual monitoring program elements and results of key findings. The annual report summarizes information regarding the status and trends of the Kings River fishery, physical conditions affecting habitat quality and availability for rainbow trout within the river, and provides guidance and recommendations for future actions and modifications to the program. Documentation of data and other relevant information are included as technical appendices.

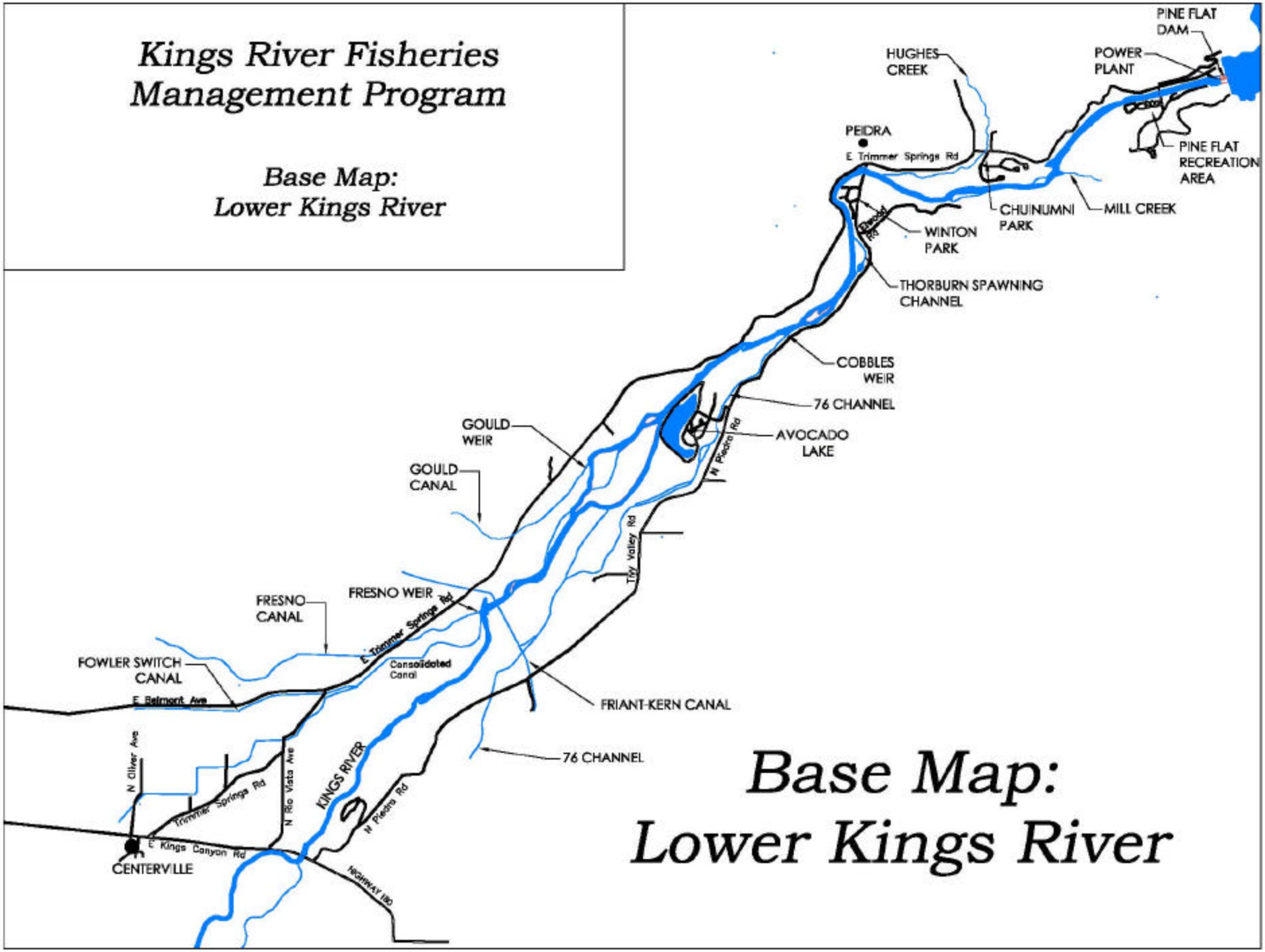


Figure 1-1 – Map of Lower Kings River and Key Geographic Locations

2.0 HYDROLOGY AND OPERATIONS

2.1 RESERVOIR INFLOW

Daily inflow into Pine Flat Reservoir from October 1, 1999 through May 30, 2003 is shown in Figure 2-1. Inflow into Pine Flat Reservoir is characterized by high seasonal and inter-annual variability reflecting variation in precipitation, snow pack, and runoff within the watershed. The total estimated annual inflow into Pine Flat Reservoir, and the corresponding percent water year is summarized below (Table 2-1):

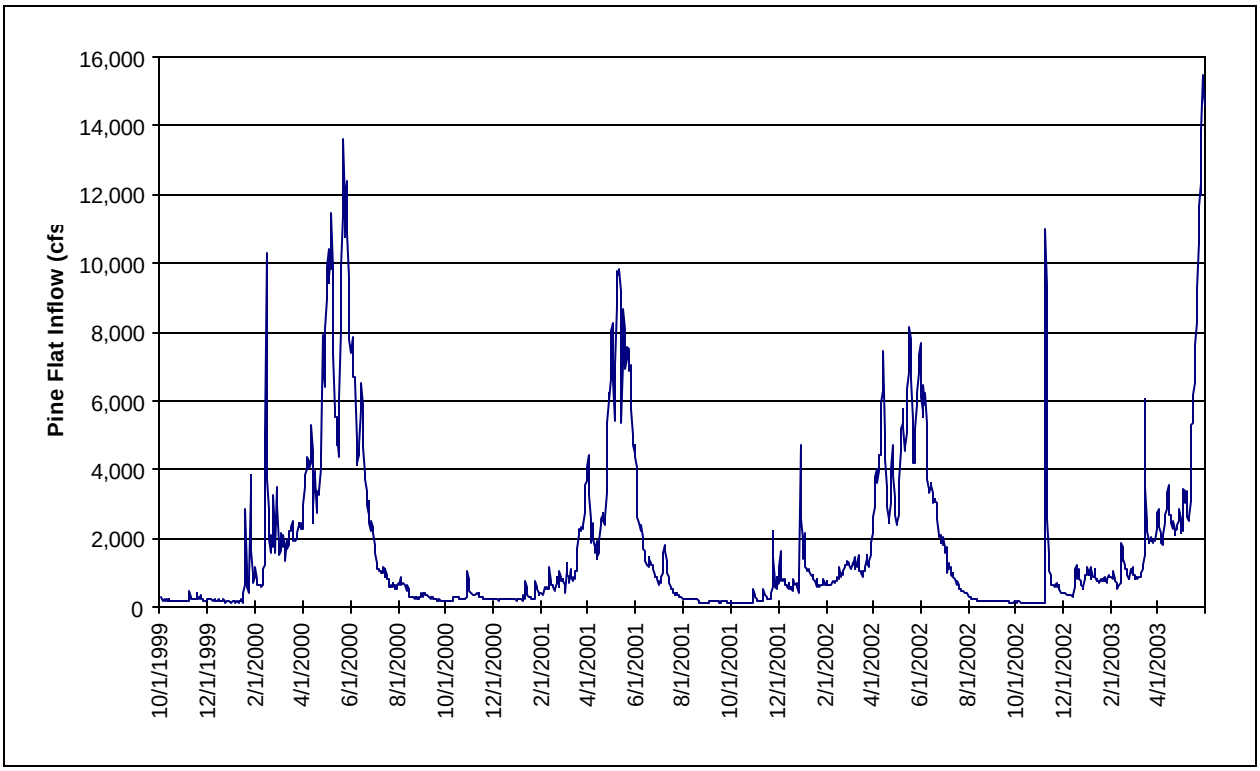


Figure 2-1 – Daily inflow into Pine Flat Reservoir between October 1, 1999 and May 30, 2003.

Period	Annual Runoff (TAF)	Percent Water Year
October 1999 -- September 2000	1,534.260	90%
October 2000 -- September 2001	1,010.187	59%
October 2001 -- September 2002	1,140.716	67%
October 2002 -- September 2003	1,426.148	84%

Table 2-1 – Annual runoff in thousands of acre-feet (TAF) and percent water year from October 1999 through September 2003.

Note: A tabular summary of daily inflow into Pine Flat Reservoir is presented in Appendix A.

2.2 RESERVOIR STORAGE

Daily reservoir water storage volume and water surface elevation in Pine Flat Reservoir from October 1999 through May 2003 is shown in Figure 2-2. Reservoir storage reflects the combined effects of reservoir inflow, releases from Pine Flat Reservoir to the lower Kings River, and evaporation. As part of the Framework Agreement, a voluntary 100,000 acre-foot temperature control pool was established. Reservoir operations since implementation of the Framework Agreement have retained the temperature control pool at or above the 100,000 acre-foot pool. Maintenance of the temperature control pool provides enhanced cold water storage in Pine Flat Reservoir and the ability to achieve enhanced water temperature conditions for cold water fish species within the reservoir (provided oxygen levels are adequate) and the lower river after completion of the annual irrigation releases. Results of water temperature monitoring in the lower Kings River are presented in Section 3.1.2.

2.3 RESERVOIR RELEASES

Water releases from Pine Flat Reservoir to the lower Kings River show high variability within and among years as shown in Figure 2-3. Releases from Pine Flat Reservoir during the late fall, winter, and spring months have been in accordance with the Exhibit C flow schedule established by the Framework Agreement. Beginning in the early spring, releases from Pine Flat Reservoir increase in response to downstream water demand and irrigation delivery schedules for water from storage. Average daily flow in the lower Kings River October 1999 through May 2003 ranged from 100 to 7,465 cubic feet per second (cfs) (Figure 2-3).

The Framework Agreement established minimum instream Exhibit C flows as release from Pine Flat Reservoir, flow at Piedra, in Dennis Cut, at Fresno Weir and below Fresno Weir to support resident fish populations in the lower river. Results of daily flow measurements below Fresno Weir from October 1999 through May 2003 have demonstrated compliance with the instream flow requirements as outlined in the Framework Agreement. Flows are measured and reported when irrigation demands are inadequate to meet the Exhibit C flow criteria (Figure 2-4). Information on

daily water releases from Pine Flat Reservoir and daily flow measured at Fresno Weir is summarized in Appendix A.

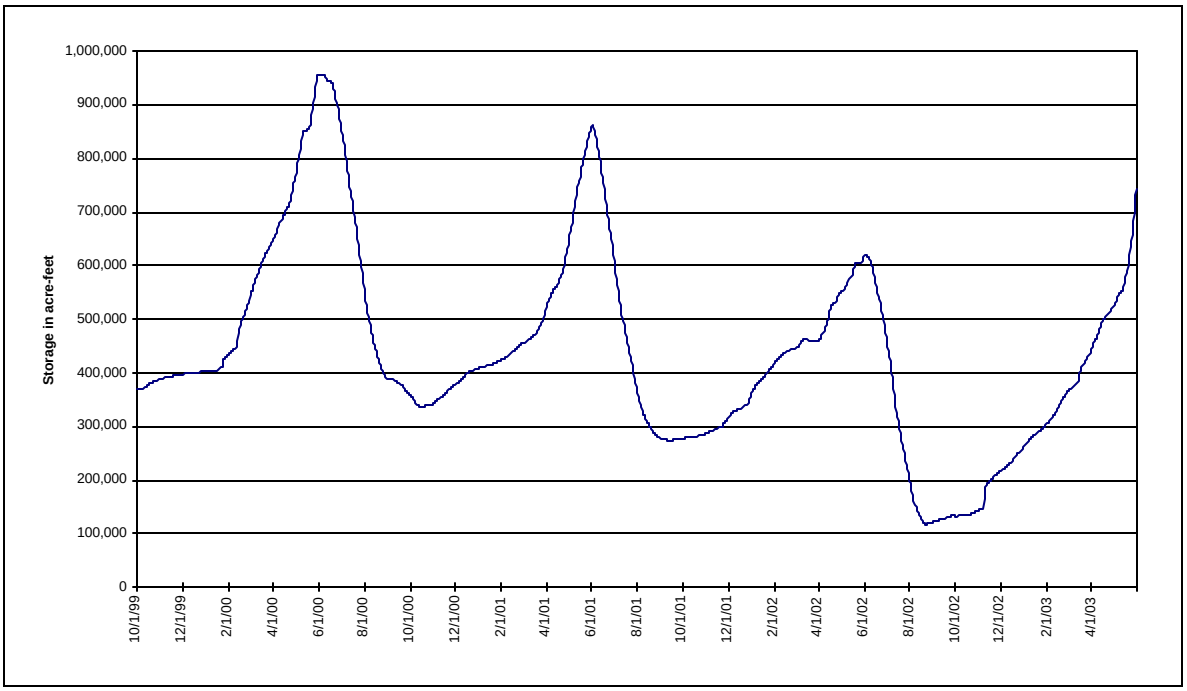


Figure 2-2 – Daily storage volume in Pine Flat Reservoir from October 1999 to May 2003

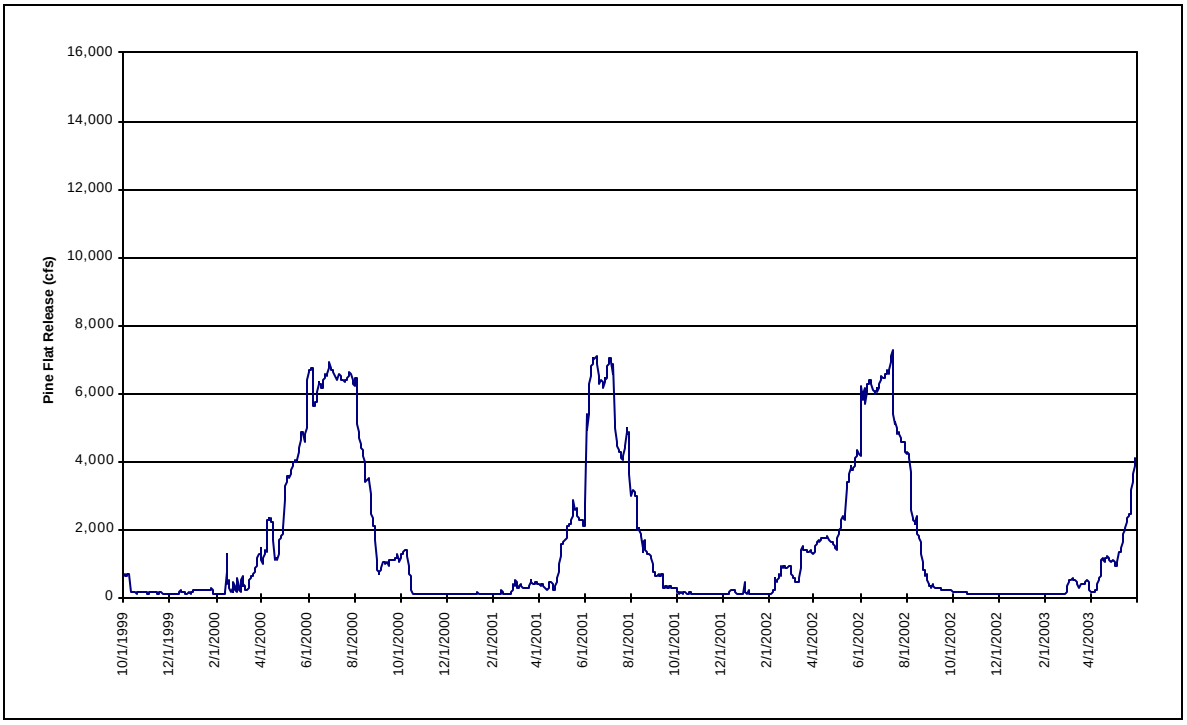


Figure 2-3 – Average daily water releases from Pine Flat Reservoir to the lower Kings River between May 1999 and May 2003.

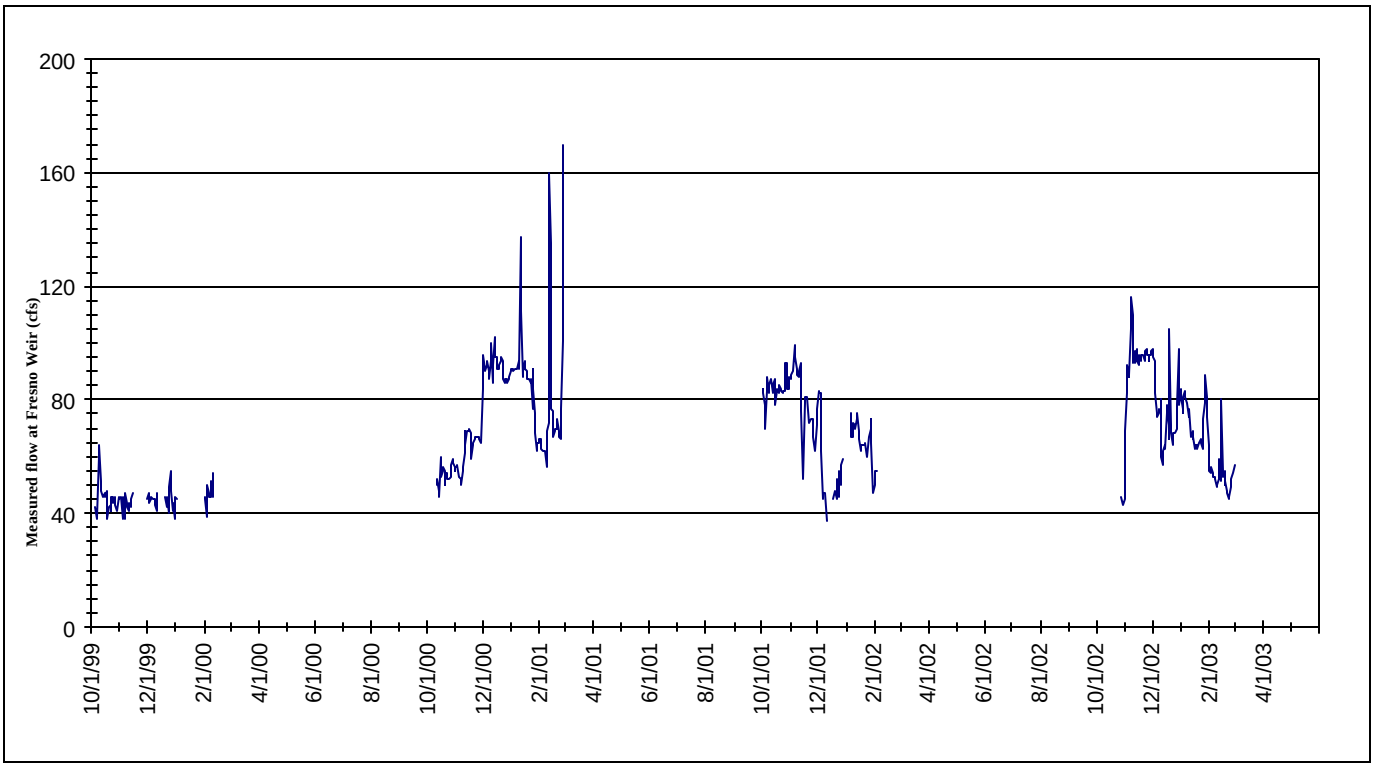


Figure 2-4 – Measured average daily flows (cfs) in the Kings River below Fresno Weir from October 1999 through May 2003.

2.4 TELEMETRY SYSTEM

During 2002-2003, KRWA implemented a water temperature and flow monitoring station that provides real-time (telemetry) temperature and flow information at Fresno Weir. This system provides data that supports informed decisions on water temperature and flow management after completing the irrigation and delivery season when elevated water temperatures may affect habitat quality for trout within the lower river. The real-time telemetry water temperature monitoring system complements the ongoing temperature monitoring at fixed locations within the river (Section 3.1.2) for use in evaluating factors affecting habitat conditions and the potential health and condition of trout within the river.

An extensive investigation into monitoring equipment and radio frequencies available in the area for a telemetry system was completed as part of the design of the telemetry system. The KRWA negotiated a long-term rental for a 200MHz frequency radio transmitter, which has been installed and is currently operating. Information from the telemetry system, which includes both water temperature and river flow at Fresno Weir, is available to the fishery program. The telemetry system has the capacity to be expanded to include real-time monitoring and data transmission from a variety of other locations along the river. Since the KRWA will be using the frequency on a river-wide basis, KRWA paid for the cost of the investigation and the long-term equipment rental fee. The fishery program will pay for the cost of equipment at the two sites approved by the ExCom. These include Fresno Weir and the Dennis Cut, a regulated diversion (side channel) from the Kings River. The Fresno Weir site has been operational since September 2002. An example of the remote water temperature and flow monitoring data, available from the telemetry system, is shown in Figure 2- 5.

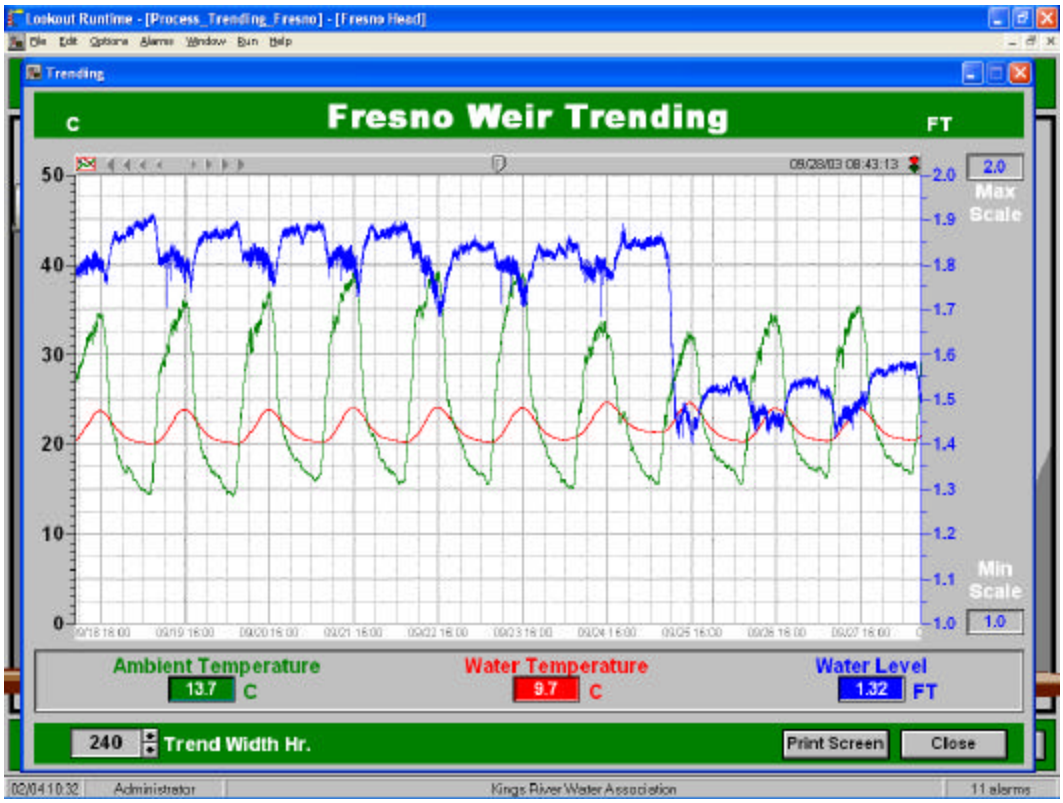


Figure 2-5 - Example of the remote water temperature and flow monitoring data at Fresno Weir.

2.5 TURBINE BYPASS PROJECT

The turbine bypass project was completed in March 2003. The project was developed through the U. S. Army Corps of Engineers (ACOE) Pine Flat Dam Fish and Wildlife Habitat Restoration Investigation that began in 1993. The turbine bypass project was implemented by the COE and KRCD under Section 1135 of the Water Resources Development Act of 1986, as amended. The project modification report for the turbine bypass project was completed in September 1996, and the project was authorized for construction in Section 105(b) of the Water Resources Development Act of 1999. KRCD served as the local sponsor with contributions from the CDFG, KRWA, and California Department of Water Resources . The turbine bypass provides increased flexibility in operating and managing flows and water temperatures released from Pine Flat Dam. The turbine bypass is operated by KRCD.

The approximately 6-million dollar project involved constructing a conduit system to the existing penstocks to allow for low flows to bypass the power plant turbines. This allows greater flexibility in making releases at various water elevations in Pine Flat Reservoir by allowing releases through the penstocks when flows are less than the 500 to 600 cfs necessary to run the power plant. In this way, there is more flexibility given to the limited releases of colder water made into the river from the reservoir to benefit the coldwater fishery during low-flow periods of the year. The turbine bypass is also used to increase the dissolved oxygen level in waters released from the power plant. Figures 2-6 and 2-7 show the dam release before and after completing construction of the project.

Figure 2-6 - Construction of Turbine Bypass Project.

Figure 2-7 - Completed Turbine Bypass Project, March 2003.

2.6 EXHIBIT C AND D FLOWS

Section 1(e) of the Framework Agreement calls for the KRWA to diligently endeavor to increase the minimum water flows in the Kings River downstream of Pine Flat Dam as set forth in Exhibit C to those levels shown in Exhibit D by October 1, 2005. The Exhibit C flow schedule presented in the Framework Agreement is summarized in Table 2-2. Exhibit C flows have been implemented and monitored since 1999.

Exhibit C Flows (cfs)

Season	Total Flow at Piedra	Minimum Flow in Dennis Cut	Minimum Flow to Fresno Weir	Water Divertable in China Slough	Required Flow Over Fresno Weir
Oct. 1 – Nov. 15	**100**	**5**	**95**	**10**	**40**
Nov. 16 – March 31	**100**	**5**	**95**	**5**	**45**
April 1 – Sept. 30	**100**	**5**	**95**	**15**	**35**

Table 2-2 – Exhibit C flows (cfs) from the Framework Agreement.

A KRWA Exhibit D committee has been formed and is meeting regularly to develop programs that will enable the KRWA to reach the Exhibit D flow goals while avoiding unacceptable water supply or operational impacts to its member units.

Some ideas that are under discussion include re-operations of irrigation demands and/or the temperature control pool, groundwater recharge and banking projects, exchange arrangements with the State Water Project (SWP), downstream surface storage projects, and member contribution of entitlement/storage. As the potential cost/benefit and feasibility of these different concepts are developed, formal engineering studies and analysis will be required. While none of the ideas developed to date are ready for review by the program, the Exhibit D committee is optimistic that a number of the ideas hold great promise for future implementation.

2.7 Summary and Discussion

Hydrologic conditions and Pine Flat Reservoir operations and flows within the lower river during 2002-2003 are characterized by high seasonal variability characteristic of the Kings River watershed and water supply operations. Findings and recommendations regarding hydrology and operations include:

- Pine Flat Reservoir operations were successful in maintaining the temperature control pool in the reservoir above the minimum level specified in the Framework Agreement;

- The reservoir releases were characterized by relatively high stream flows during the irrigation season, which were substantially reduced during the non-irrigation season. Average daily streamflows, as measured at Fresno Weir, were in compliance with the minimum streamflow requirements contained a Framework Agreement throughout 2002-2003;

- A real-time telemetry system has been installed and is providing information on water temperature and flow at Fresno Weir that is available for monitoring and managing conditions within the lower river as part of the fishery program;

- The turbine bypass project has been completed and is operational. The turbine bypass provides additional flexibility in managing the cold water pool within Pine Flat Reservoir and the temperature of water released into the lower river to support suitable habitat conditions for trout as part of the fishery program; and

- Planning activities were conducted by KRWA during 2002-2003 to establish a framework of agreements necessary to achieve Exhibit D flows by October 2005. The TSC supports the activities of the Exhibit D committee and a continued focus on establishing the framework of agreements necessary to successfully implement Exhibit D flows as outlined in the Framework Agreement.

3.0 WATER QUALITY

Water quality monitoring as part of the fishery program has focused principally on measurements of water temperature and dissolved oxygen concentrations that directly affect habitat quality for fish and macroinvertebrates within Pine Flat Reservoir and the lower Kings River. Results of water temperature and dissolved oxygen monitoring within the reservoir and lower river are discussed below.

3.1 WATER TEMPERATURE MONITORING

Habitat quality and availability to support resident trout within the lower Kings River is dependent, to a large extent, on the suitability of seasonal water temperature conditions. Water temperatures within the lower Kings River are affected by a variety of environmental factors including, but not limited to, the temperature of water released from Pine Flat Reservoir, air temperature, streamflow, and the distance downstream from Pine Flat Reservoir. Given the importance of water temperature as a factor affecting habitat conditions for trout within the lower river, the fishery management program (FMP) includes an extensive water temperature monitoring component designed to provide information on water temperature conditions within Pine Flat Reservoir and at various locations in the lower river as briefly discussed below.

3.1.1 Reservoir

Water temperature and dissolved oxygen profile measurements have been made within Pine Flat Reservoir on approximately a monthly basis since 1986. Measurements are made at a monitoring location approximately 0.5 miles upstream of the dam using a Yellow Springs Instrument (YSI) portable water quality meter. Vertical profile measurements of both water temperature and dissolved oxygen concentrations are made at approximately 3 foot intervals for use in characterizing limnological conditions within Pine Flat Reservoir in the immediate vicinity of the dam outlet structures. Results of water quality measurements have shown a characteristic seasonal pattern of thermal stratification beginning in the spring between the reservoir hypolimnion (cold water near the bottom) and epilimnion (warmer water near the surface) increasing through the summer months. Reservoir stratification continues into the fall at which time atmospheric cooling results in fairly uniform water temperatures throughout the reservoir (reservoir destratification) and reservoir turnover, which typically occurs in the late fall. Results of the May 2002 reservoir profile are presented in Figure 3-1 as an example of reservoir profile measurement results. Results of monthly vertical reservoir temperature and dissolved oxygen profile measurements during the period May 2002 through May 2003 are summarized in Appendix B. Additional vertical profile temperature measurements, collected during previous years, are on file at KRCD.

Results of the reservoir temperature and dissolved oxygen measurements are used as part of fishery management program to determine both the dissolved oxygen concentration and temperature of water released from the reservoir into the lower river. The data are also used in temperature control pool management during the fall months after completion of the irrigation season to provide suitable habitat conditions to support trout and other fish species within Pine Flat Reservoir. In addition to the vertical temperature profile measurements, water temperature is

measured by KRCD at each of the individual outlet ports on Pine Flat Dam. Water temperature at each outlet is available on a real-time basis for use in evaluating water temperature released from the reservoir into the lower Kings River. Results of daily water temperature monitoring at each of the individual outlet port locations is summarized for May 2002 through May 2003 in Appendix C.

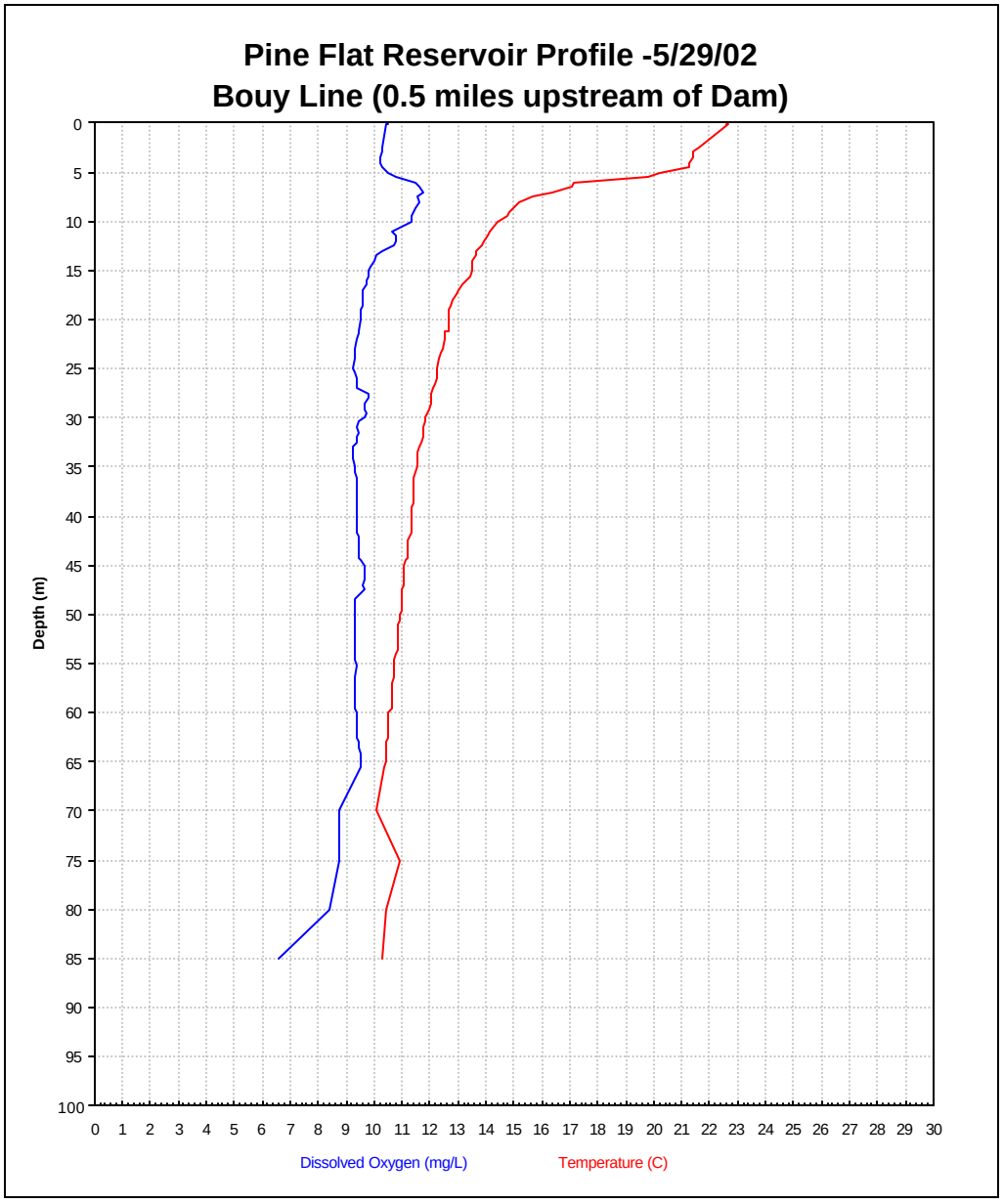


Figure 3-1 – May 2002 vertical reservoir temperature and dissolved oxygen profile measurements at Pine Flat Reservoir.

3.1.2 River

Water temperature within the lower Kings River is routinely monitored at a variety of locations extending from Pine Flat Dam downstream to Highway 180. Permanent monitoring locations within the lower river are shown in Figure 3-2. Water temperature is recorded at each location using a computerized temperature sensor and data recording system (Onset temperature recorders) which are routinely calibrated to laboratory standards and provide temperature monitoring accuracy within $\pm 0.5^{o}$ C. Water temperature at each location is recorded at two-hour intervals throughout the year. In addition, as part of monitoring conducted specifically for the fishery management program (Section 3.4), additional water temperature monitoring locations have been established for temperature monitoring during the late summer and fall after completion of the irrigation season.

Results of water temperature monitoring within the lower Kings River are shown, for example, at the Army Corps Bridge and Fresno Weir for May 2002-May 2003 (Figure 3-3). Results of water temperature monitoring at other locations within the river are included in Appendix D.

Results of temperature monitoring within the river have shown a general seasonal pattern with lowest temperatures occurring during the winter and early spring, increasing during the spring and summer months, with the greatest increase in seasonal temperatures occurring during the late summer and early fall after completion of the irrigation season. Results of temperature monitoring have also shown a general gradient of temperatures with the coldest temperatures occurring typically near Pine Flat Dam and increasing as a function of distance downstream within the lower river during summer months. In addition, results of temperature monitoring have shown that the diel temperature variation (e.g., difference between the maximum and minimum daily temperature) is typically lowest immediately downstream of Pine Flat Dam with daily temperature variation increasing as a function of distance downstream within the lower river (Figure 3-3).

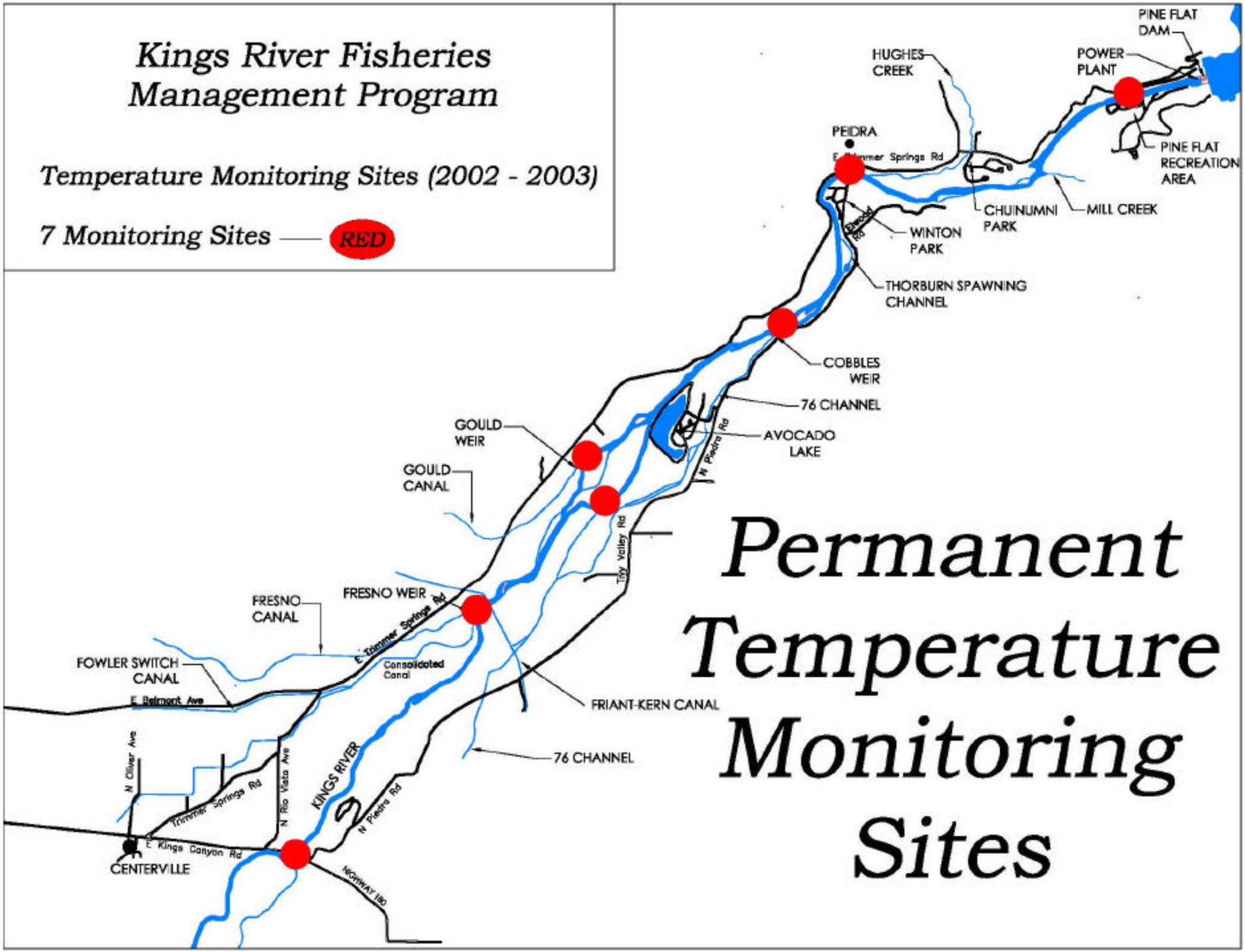
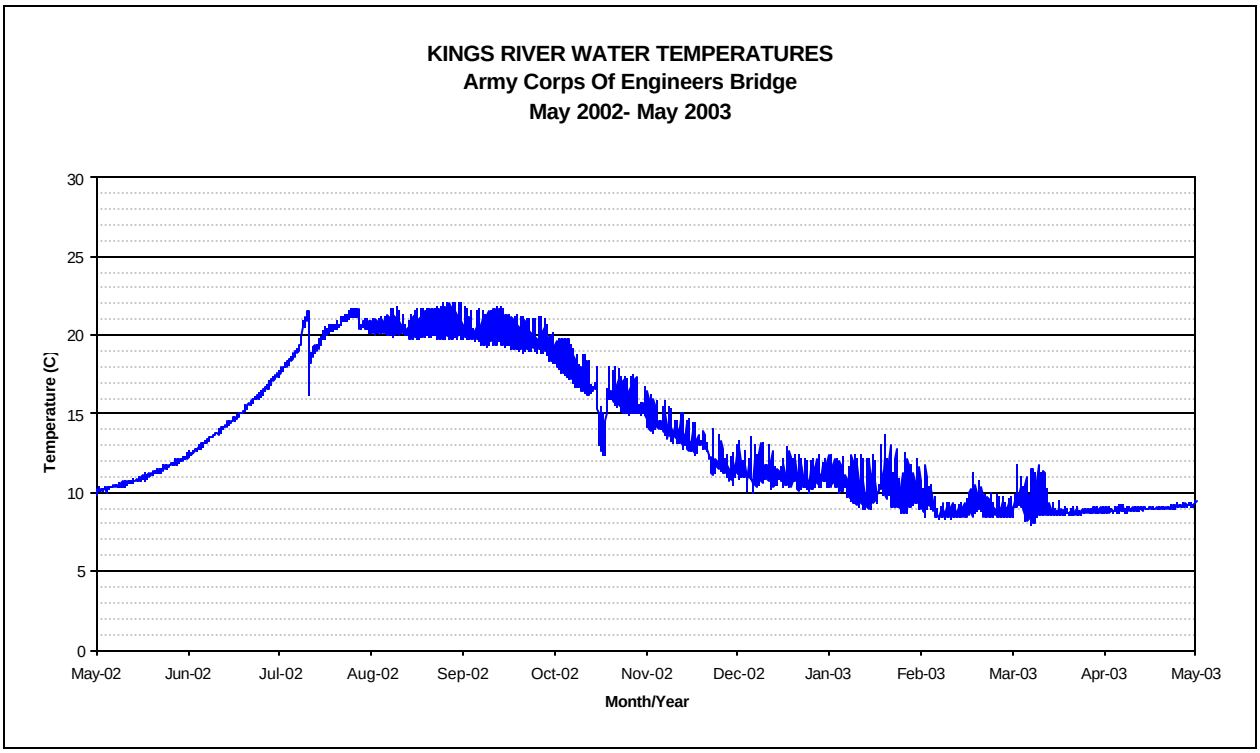


Figure 3-2 – Permanent Water Temperature Monitoring Locations on the Lower Kings River.

A substantial body of information exists on the habitat suitability and response of trout to water temperatures. A variety of factors influence habitat suitability including, but not limited to, the average and daily maximum temperature, the duration of exposure to elevated temperature, diel temperature variation, prey availability, fish condition and stress, availability of microhabitat temperature refugia, and other factors. As a result of these interacting factors specific water temperature criteria have not been identified for use in evaluating habitat conditions but rather, general guidelines have been established to assess habitat conditions within the lower river. Information from the scientific literature was used by the TSC to assess conditions within the river during the 2002-2003 study period. As a general guideline, water temperatures within the range from approximately 15-18 C have been identified as providing optimal habitat conditions for trout (Moyle 2002). Habitat conditions for trout were identified as stressful as average daily temperatures approach or exceed approximately 21 C or maximum daily temperatures approach or exceed 25 C.. As water temperature becomes elevated above the optimal range, quality and availability of habitat within the river to support cold-water species such as rainbow trout may decrease. As part of the fishery program, water temperature data collected through the ongoing monitoring program are continuing to be analyzed and evaluated, in addition to the evaluation of alternative management strategies, after completion of the irrigation season, and prior to seasonal declining atmospheric temperatures during the fall months (Section 3.4) to help maintain suitable conditions for trout.

Results of water temperature monitoring at the ACOE Bridge (Figure 3-3) showed that seasonal temperatures were generally lower than temperatures observed downstream at Fresno Weir. Water temperature throughout the reach was within the range considered to provide suitable habitat conditions for resident trout during most of the year. Water temperatures during the late summer-early fall, 2002, particularly at Fresno Weir (Figure 3-3), were within the range considered to be stressful to trout. Maximum daily temperatures at Fresno Weir were observed up to approximately 26 C with average daily temperatures exceeding 21 C on a number of days during the period from approximately mid-July through August (Figure 3-3). Diel temperature variation during the summer at Fresno Weir (difference between maximum and minimum daily temperature) typically ranged from 3-4 C. Water temperature at Fresno Weir, and at other locations within the lower river, was monitored (Appendix D) as part of the evaluation of habitat conditions. Although late summer-early fall temperatures within the lower river were elevated, and within a range considered to be stressful for trout, there was no evidence that these temperature conditions resulted in trout mortality. The TSC is continuing to investigate and evaluate water temperature conditions affecting the quality and availability of habitat within the lower river for trout during the late-summer and early-fall and the effectiveness of various management actions, including operation of the turbine bypass (Section 3.4), to provide suitable habitat conditions downstream to Fresno Weir for resident trout throughout the year.



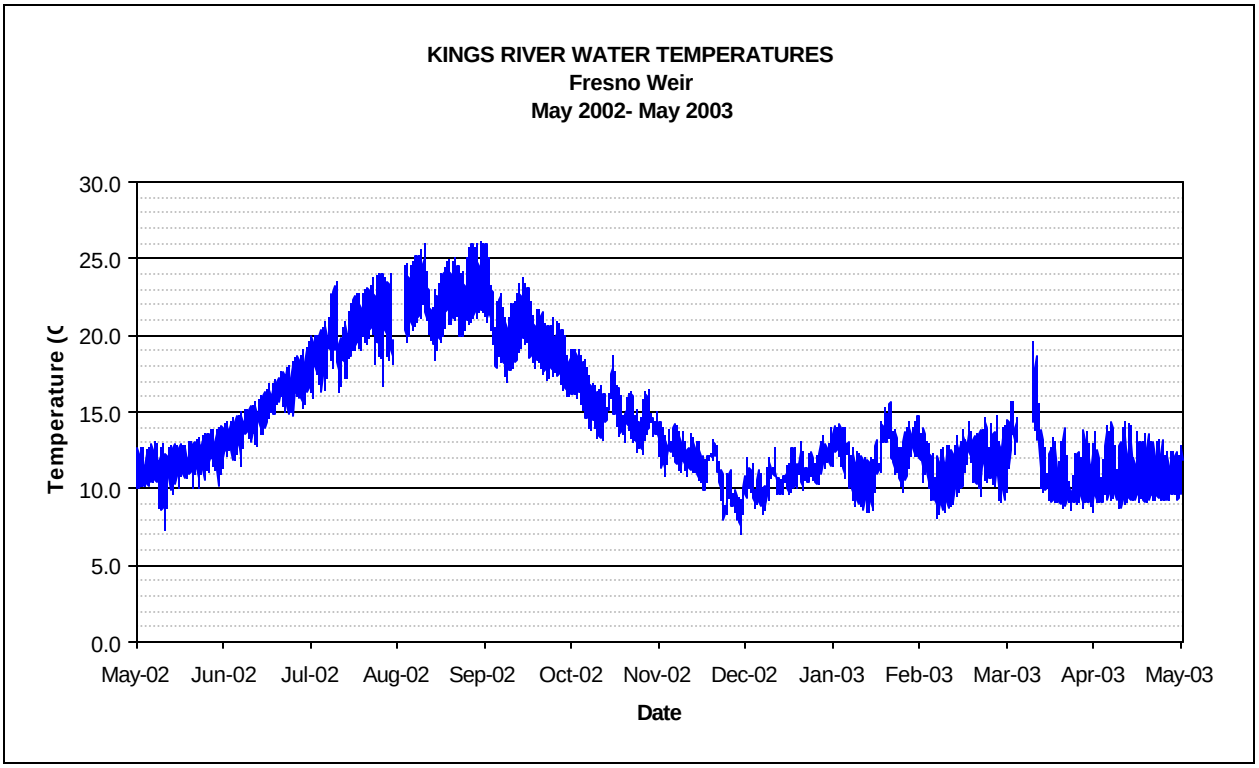


Figure 3-3 –Water temperature monitoring at the Army Corps Bridge and Fresno Weir, May 2002-May 2003 showing differences in diel temperature variation as a function of distance downstream of the dam.

3.2 DISSOLVED OXYGEN MONITORING

Dissolved oxygen concentrations are measured both within Pine Flat Reservoir and within the lower Kings River at the Army Corps Bridge. Results of dissolved oxygen monitoring, conducted by KRCD, are briefly summarized below.

3.2.1 Reservoir

As briefly described above, KRCD conducts monthly monitoring within Pine Flat Reservoir to evaluate vertical profiles in both water temperature and dissolved oxygen concentrations. Results of dissolved oxygen measurements have shown a seasonal pattern, which is strongly associated with reservoir stratification; in which dissolved oxygen concentrations throughout the water column within the reservoir are typically within a suitable range for fish (6 mg/l and above) during the winter and early spring months. As the reservoir becomes thermally stratified (Section 3.1.1) during late spring and summer months, a vertical distribution of dissolved oxygen concentrations becomes apparent with greater dissolved oxygen levels in the upper part of the water column (warmer epilimnion waters) and decreased dissolved oxygen concentrations in the colder waters near bottom (hypolimnion). The hypolimnion containes very low levels of oxygen at times and would not sustain a trout population . These seasonal patterns in the vertical distribution of dissolved oxygen concentrations within Pine Flat Reservoir are typical of other reservoirs located within the Central Valley, though the actual values may differ significantly. Results of dissolved oxygen monitoring within Pine Flat Reservoir during the period May 2002 through May 2003 are shown in Appendix I in combination with results of vertical water temperature profile measurements. Additional information on results of dissolved oxygen monitoring conducted within Pine Flat Reservoir is on file at KRCD. In addition to monitoring dissolved oxygen concentrations within the reservoir, KRCD also monitors dissolved oxygen concentrations in the water released from Pine Flat Reservoir into the lower Kings River. Monitoring is conducted at the reservoir outlet works to determine both the minimum dissolved oxygen concentrations and potential oxygen super saturation resulting from releases through the hydroelectric generator outlet works.

3.2.2 River

KRCD routinely monitors dissolved oxygen concentrations within the lower Kings River at the Army Corps Bridge, which is located 0.6 miles downstream of Pine Flat Dam. Dissolved oxygen concentrations are measured on a continuous basis using an YSI dissolved oxygen meter routinely calibrated to laboratory standards with an accuracy of ± 0.5 mg/l (Figure 3-4). As a condition of the Federal Energy Regulatory Commission (FERC) license, KRCD is required to maintain a minimum dissolved oxygen concentrations at the Army Corps Bridge of 7.0 mg/l for the protection of fish and other aquatic organisms inhabiting the lower Kings River when the power plant is in

Figure 3-4 – Monitoring station on the ACOE Bridge.

operation. Results of dissolved oxygen concentrations measurements at the Army Corps Bridge during the period from May 2002 through May 2003 are summarized in Figure 3-7. Additional information on dissolved oxygen measurements made within the lower Kings River is on file at KRCD. Results of these measurements have shown that dissolved oxygen concentrations within the lower Kings River are typically within the range considered to be suitable for various fish and macroinvertebrate species that occur in this section of the river.

3.3 COMPLIANCE WITH DISSOLVED OXYGEN REQUIREMENTS

Minimum dissolved oxygen concentrations specified by the FERC license are 7.0 mg/l when the power plant is in operation. Dissolved oxygen levels less than 7.0 mg/l were not of sufficient duration to impact the fishery. The minimum, maximum and mean monthly dissolved oxygen level at the ACOE Bridge are summarized in Table 3-1. During 2002-2003, KRCD met its operating and monitoring requirements, and conditions were suitable for fish throughout the period. Results of the monitoring are presented in KRCD's report "Dissolved Oxygen Monitoring, Final Report for Calendar Year 2002" (KRCD 2003) which is on file at KRCD.

KINGS RIVER POWER PLANT
Dissolved Oxygen at ACOE Bridge

Month-Year	Minimum	Mean	Maximum
May-02*	7.98	9.89	12.06
June-02*	8.72	9.80	10.20
July-02*	6.86	8.97	9.55
August-02*	6.86	8.42	10.11
September-02*	6.18	9.09	10.50
October-02*	5.91	8.10	9.69
November-02	5.81	8.39	9.27
December-02	10.27	11.04	12.23
January-03	9.99	10.97	13.33
February-03	7.68	9.34	10.93
March-03*	7.61	9.41	12.40
April-03*	8.67	9.76	12.22
May-03*	8.40	9.18	10.01

Table 3-1 - Minimum, maximum and mean daily dissolved oxygen level at the ACOE Bridge from May 2002 through May 2003.

*Power plant in operation

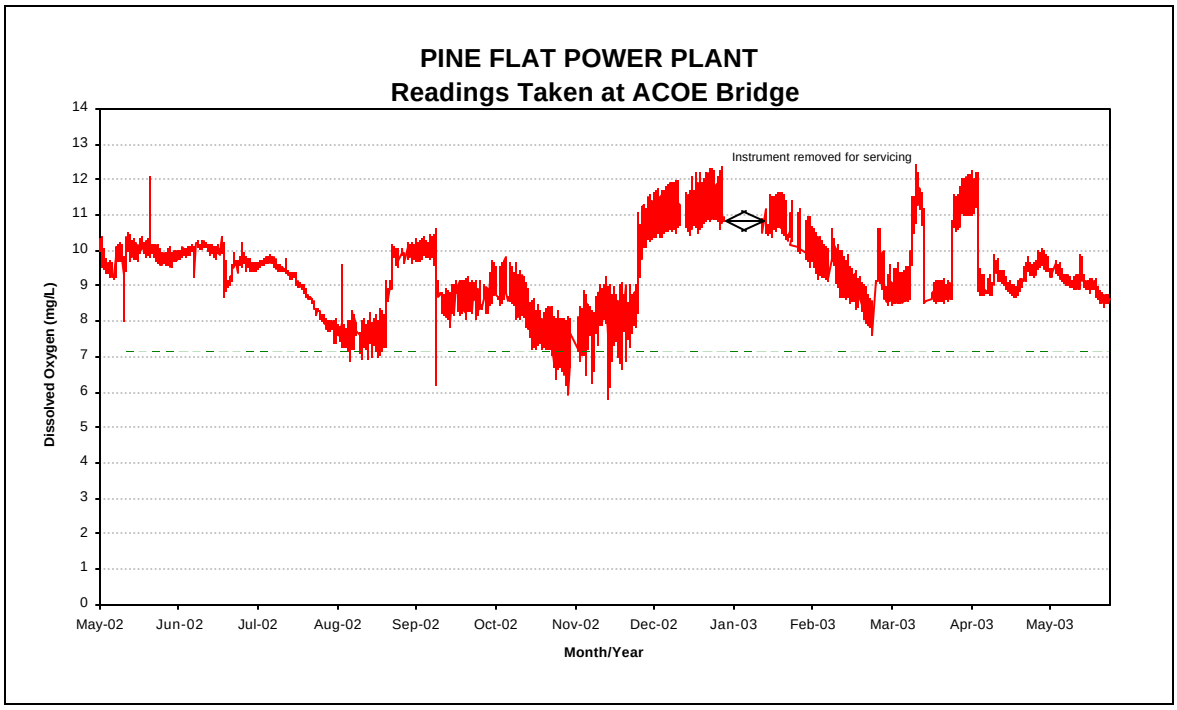


Figure 3-7 - Dissolved oxygen concentrations measurements at the Army Corps Bridge from May 2002 through May 2003.

3.4 PLANNING FOR WARM WATER TEMPERATURE EVENT

One of the fundamental goals and objectives, as outlined in the Framework Agreement, is the maintenance of suitable instream habitat conditions for trout throughout the year downstream to Fresno Weir. Water temperature in the lower Kings River during the early fall, after completion of irrigation demand releases, may become elevated to a level where habitat conditions are stressful and/or unsuitable for trout. Having real-time temperature data available allows for informed decisions by managers to perform operations, as needed, for temperature maintenance of water downstream of Pine Flat Dam in an effort to maintain suitable water temperatures for cold water species such as rainbow and brown trout. Several management strategies have been identified for addressing temperature maintenance issues including: 1) short-term (pulsed) water releases from Pine Flat Reservoir; 2) rescheduling of water deliveries to KRWA member units; 3) selective releases from the dam's three levels of gates, and 4) beginning in 2003, the operation of the turbine bypass to maintain downstream temperatures within an acceptable range. These alternative operational strategies have also been identified and will continue to be developed by the TSC to maintain suitable water temperature conditions during the late-summer and fall months.

As part of the fishery program, additional water temperature monitoring locations were established during the summer 2002 to provide information on water temperature conditions and habitat suitability for resident rainbow trout within the lower Kings River during the late summer and early fall after completion of the irrigation season. The permanent water temperature-monitoring network (Figure 3-2) was augmented by placing additional temperature monitoring units at approximately 0.5 miles intervals downstream from Pine Flat Dam to the Highway 180 Bridge. Water temperature was measured at each location at one-hour intervals to evaluate changes in the longitudinal gradient of water temperatures within the lower Kings River in response to changes in streamflow during the late summer and fall.

Results of water temperature monitoring were analyzed to assess the response of water temperature (increases or decreases in water temperature as a function of distance downstream from Pine Flat Dam). A comparative analysis of water temperature measured at the Army Corps Bridge and Fresno Weir are shown in Figure 3-6 for the period from August through November, 2002. Results of these analyses demonstrated that daily variation in water temperature increases as a function of distance downstream of Pine Flat Dam during the summer and early fall months (Figure 3-6). Mean daily water temperatures on selected dates between September and November, 2002 (Table 3-2) showed that during September average daily temperatures were as much as $2.6^{O}C$ greater at Fresno Weir when compared to the ACOE Bridge. Mean daily temperatures decreased at Fresno Weir, compared to ACOE temperatures, beginning in late September and continued to show a decreasing trend through the fall months (Table 3-2). Average daily temperatures at the ACOE Bridge were consistently within the range considered to provide suitable habitat for trout (average daily temperatures less than $21^{O}C$) though the trout might be somewhat stressed. Average daily temperatures observed at Fresno Weir during the September-November, 2002 period (Table 3-2) showed that during late August, September, and early October (October 8 observations) water temperatures were within the range considered to be stressful to trout. The observed temperatures were maintained at levels that, although stressful in the lowermost reach of the lower river, were not expected to result in lethal conditions for trout.

Water temperature data collected during the late-summer and fall, 2002 at 0.5 mile intervals within the lower river were analyzed to assess trends in water temperature as a function of distance downstream of the dam (ACOE Bridge to Highway 180). Mean daily, minimum, and maximum daily temperatures were determined for selected dates between August and November, 2002 and used to plot linear regressions of water temperature as a function of distance (miles) downstream of the dam. Results of these analyses showed typically linear increasing and decreasing trends in temperature (as evidenced by the high r^2 values for the regressions) with distance. General trends in water temperatures are shown in Figure 3-7 illustrating a period of increasing temperatures downstream of the dam (September 15) and decreasing temperatures (November 1). Results for monitoring in August (August 1, 8, 15, 22, and 29) showed relatively little change in temperatures with distance (temperature decreased 0.005 and 0.03 C per mile on August 1 and 8, and showed an increasing trend of 0.64, 0.05, and 0.15 C per mile on August 15, 22, and 29, respectively). Results for September primarily showed an increasing temperature trend with increases of 0.24 C per mile on September 1, 0.03 C per mile on September 8, 0.22 C per mile on September 15, and 0.23 C per mile on September 22. Data for September showed a decreasing trend of 0.09 C per mile reflecting the variability in water temperature response within the lower river under different flow and atmospheric conditions. Temperatures in October showed decreasing trends on October 1 (0.08 C per mile), October 15 (0.07 C per mile), October 22 (0.15 C per mile), and October 29 (0.17 C per mile), with an increasing trend observed on October 8 (0.06 C per mile). Results of temperature monitoring in November showed a consistent trend of decreasing temperatures (0.24 C per mile November 1; 0.13 C per mile November 8; 0.15 C November 15; 0.11 C November 22)..

Water temperatures within the lower river were maintained within the range considered to be suitable, although potentially stressful at the lowermost reaches, for trout throughout the late-summer and fall of 2002. Temperature management during this period was achieved, in part, by modifying operations of Pine Flat Dam to allow release of cold water to the lower river through the low-level sluice gates when needed. Reservoir releases for the FMP during this period were coordinated between KRCD, KRWA and ACOE using results of real-time water temperature monitoring at Fresno Weir and other locations to manage reservoir releases to maintain suitable habitat conditions for trout. In the future, operation of the turbine bypass, which became available for water temperature management in 2003, will provide greater flexibility in managing water temperature releases from the dam to maintain suitable fish habitat in the lower river.

Water temperature, and corresponding habitat suitability for trout, within the lower Kings River was a function of geographic distance downstream from the dam, the water temperature released from the dam into the lower river, the magnitude of streamflow, and the effect of atmospheric warming on temperature within the river. After approximately early October the seasonal declining atmospheric temperatures resulted in a general trend of reduced water temperatures as a function of distance downstream from Pine Flat Dam, particularly during periods when streamflow releases to the lower Kings River had been reduced to minimum flow levels (Figure 3-7). Results of these analyses provide insight into the factors affecting the trout habitat conditions within the lower Kings River associated with seasonal water temperature conditions. Results of the analyses also provide useful information for comparative purposes in evaluating alternative management strategies, including use of the turbine bypass in the future, for maintaining and enhancing suitable water temperature conditions for trout after completion of the irrigation season. Based on analyses of the available data it does not appear that water temperature monitoring is required a 0.5 mile intervals to detect differences in a longitudinal

gradient temperatures in the lower river. Based on results of these analyses the TSC has recommended that future water temperature monitoring retain the basic temperature network array of routine temperature monitoring stations within the lower Kings River (Figure 3-2) rather than augmenting the temperature array as was performed in 2002.

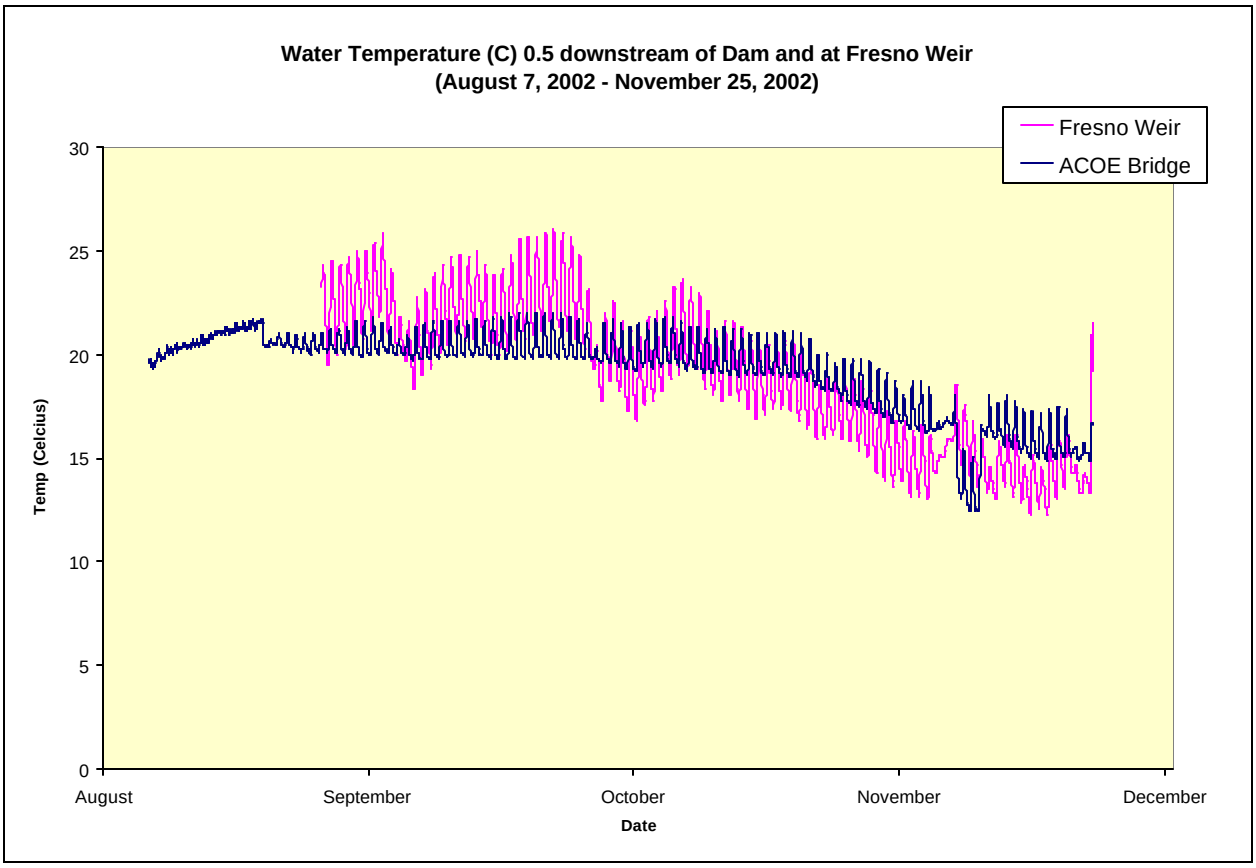
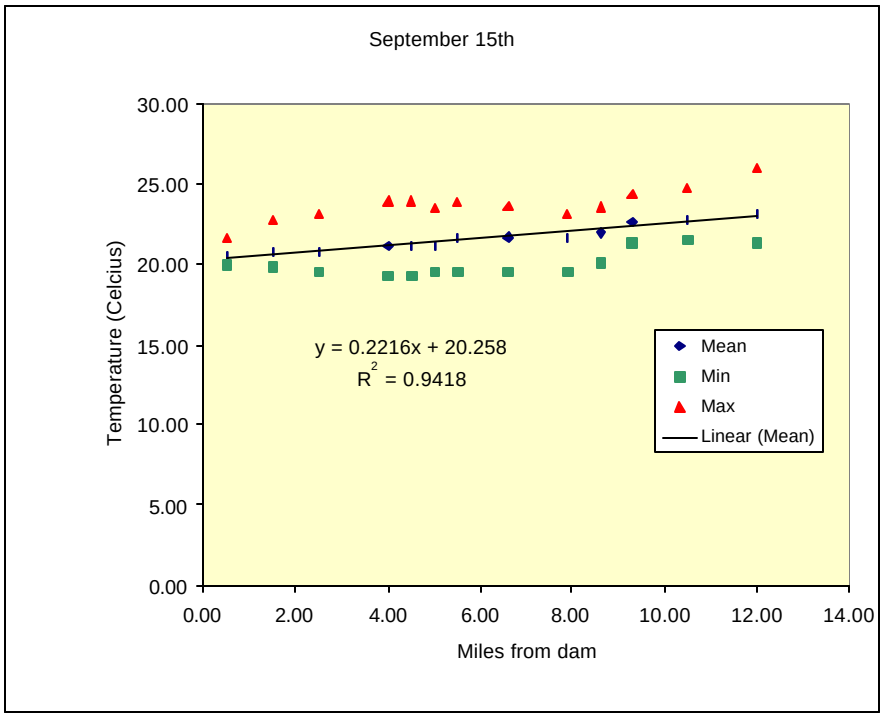


Figure 3-6 - Comparative analysis of water temperature measured at the Army Corps Bridge and Fresno Weir



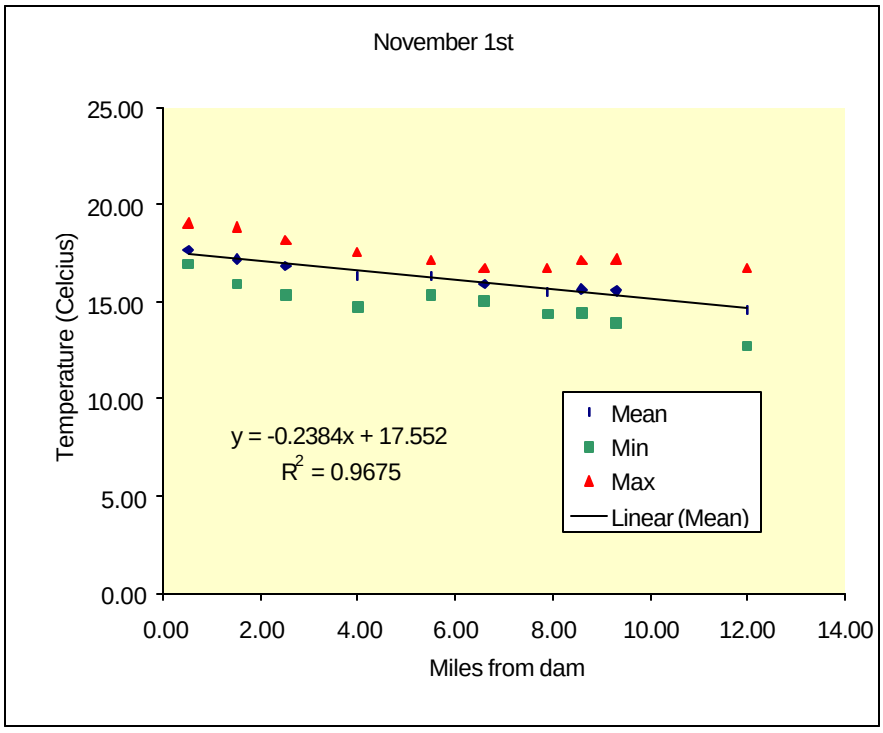


Figure 3-7 – Increasing (September 15) and decreasing (November 1) trends in water temperature as a function of distance downstream from Pine Flat (ACOE Bridge to Highway 180).

Average Daily Temperature Difference Between ACOE Bridge and Fresno Weir.

	Mean Temperature (C)		
Date	**ACOE**	**Fresno Weir**	**Difference**
1-Sep	20.55	22.92	2.37
8-Sep	20.36	20.92	0.56
15-Sep	20.48	22.53	2.05
22-Sep	20.63	23.20	2.57
29-Sep	20.25	19.66	-0.59
1-Oct	20.90	18.94	-1.96
8-Oct	20.15	21.15	1.00
15-Oct	19.77	18.95	-0.82
22-Oct	19.61	18.06	-1.55
29-Oct	18.29	16.52	-1.77
1-Nov	17.64	15.55	-2.09
8-Nov	16.73	15.53	-1.20
15-Nov	16.43	14.83	-1.60
22-Nov	15.80	14.87	-0.93

Table 3-2. Comparison of average daily water temperatures at ACOE Bridge and Fresno Weir during September-November, 2002.

3.5 Summary and Discussion

A great deal of progress has been made during this reporting period with real-time temperature monitoring and the ability to regulate and manage water temperature in the lower river during critical periods. Cooperation from the ACOE in allowing the use of the lower sluice gates to release cold water during critical periods and improved flexibility in managing water temperatures using the turbine bypass, which initiated operation in 2003, provide valuable tools for managing water temperature in the lower river to protect fish habitat.

Results of water quality monitoring within Pine Flat Reservoir and the lower Kings River during 2002-2003 have shown:

- Pine Flat Reservoir becomes stratified during late spring, summer, and fall showing a characteristic pattern of warmer water near the reservoir surface (epilimnion) and colder water with reduced dissolved oxygen concentrations near the bottom of the reservoir (hypolimnion). The reservoir destratifies in the late-fall and winter when water temperatures and dissolved oxygen concentrations become uniform throughout the water column;

- The temperature of water released from the reservoir into the lower river can be regulated and managed, to some extent, through selective operation of different outflow works, including the turbine bypass which initiated operations during 2003, however the ability to manage water temperatures is limited and constrained by the availability of cold water

and release points during various seasonal periods within the reservoir, hydroelectric generation, requirements for irrigation releases, and other factors;

- Aeration and mixing of water released from the reservoir have proven to be effective in maintaining suitable dissolved oxygen concentrations within the lower river. Mean monthly dissolved oxygen concentrations, as measured at the ACOE Bridge, during 2002-2003 exceeded 7.0 mg/l although minimum daily concentrations were slightly lower than 7 mg/l during summer and fall months. Dissolved oxygen levels measured during 2002- 2003 were within the range considered to provide suitable habitat conditions for trout and other fish and macroinvertebrates inhabiting the lower Kings River;

- Water temperatures within the lower river showed a seasonal pattern with the coldest temperatures occurring during the late winter and temperatures generally increasing during the summer and early fall;

- Water temperature showed a characteristic longitudinal gradient downstream of Pine Flat Dam. During summer months the coldest temperatures were located immediately downstream of the dam and temperatures generally increased with distance downstream from the dam. During the fall and winter, when atmospheric temperatures are cool, a reverse temperature gradient was observed with temperatures decreasing as a function of distance downstream from Pine Flat Dam;

- Water temperature within the lower river after completion of the 2002 irrigation season remained within a range considered to be suitable, although potentially stressful within the lowermost reaches, to support juvenile and adult trout. Water temperatures showed a declining trend after approximately mid-October;

- Results of temperature monitoring, and results from the fishery monitoring program, provided no evidence that either dissolved oxygen concentrations or water temperature conditions within the lower river resulted in mortality to trout or other fish species during 2002-2003; and

- Results of the 2002-2003 water temperature and dissolved oxygen monitoring are being used by the TSC to refine water quality monitoring as part of the fishery program and as a basis for evaluating alternative operational strategies, including operations of the turbine bypass, to address water quality issues affecting habitat conditions for trout in the future.

Flow volumes also had an influence on how temperatures within the river changed with distance downstream from the dam. Generally the higher the flow, the longer it took for environmental conditions to result in changes to water temperature as the water flowed downstream.

4.0 HABITAT ENHANCEMENT

A fundamental goal and objective of the fishery program is to enhance the quality and availability of habitat for a variety of fish and macroinvertebrates within Pine Flat Reservoir and the lower Kings River. As part of the 2002-2003 fishery program a variety of habitat enhancement projects were successfully implemented including a grass seeding and anchoring of cover habitat for warm water fish species within Pine Flat Reservoir and boulder placement, gravel augmentation, construction of coves and jetties, channel ripping, and other habitat enhancement projects within the lower Kings River to benefit various life stages of trout, other fish species, and macroinvertebrates. A brief description of the habitat enhancement projects implemented as part of the fishery program during 2002-2003 is summarized below.

4.1 RIVER

4.1.1 Introduction

Section 1(f) of the Framework Agreement - Funding / Projects discusses fish habitat improvements to enhance fish and wildlife resources in the lower Kings River. Habitat enhancement projects including boulder placement projects, creation of coves and jetties, channel ripping to expose spawning gravel buried beneath the armored streambed, supply areas for aggradation, and create and enhance rearing habitat for juvenile fish. These projects also provide cover, resting areas, feeding stations, and spawning areas for adult fish, and increase microhabitat for aquatic insect assemblages. Instream habitat enhancements increase the quality and availability of suitable areas for trout production, lower mortality rates, and augment food availability. The projects were planned and conducted under elements #C8 (Juvenile Rearing Habitat) and #C-2001-8 (Boulder Placement and Channel Ripping).

Several sites were selected to enhance instream habitat for juvenile and adult trout (Figure 4-1). Groups of boulders were placed at seven sites (Figure 4-2). Jetties were constructed with cobble at three areas along the rivers edge (figure 4-5). These were accompanied by the construction of coves that alternated with the jetties (Figure 4-1). Five sites were deep-ripped with a bulldozer to expose gravel and increase interstitial spaces between rocks (Figure 4-10). Spawning gravel was added at three sites (Figure 4-13).

4.1.2 Project Permitting

Permits from various state and federal agencies are required to perform work in a stream or river channel. These permits are meant to fully disclose the details of the work, and identify any negative environmental impacts that might occur and how these impacts will be avoided or mitigated. This includes any impacts to water quality. CDFG and KRCD obtained several permits from resource and regulatory agencies for the Juvenile Trout Rearing Habitat Enhancement Project and the Gravel Placement Project. Times to obtain permits ranged from two months to 1.2 years. The permit and agency from which it was obtained are shown in Table 4-1 below:

Agency	Permit
California Department of Fish and Game	1601 Permit - Stream Alteration Agreement
State Office of Planning & Research	California Environmental Quality Act - Notice of Exemption
State Reclamation Board	Encroachment Permit, Designated Floodway - Waiver
U. S. Army Corps of Engineers	404 Permit, Dredge & Fill - Clean Water Act
California EPA, Regional Water Quality Control Board	401 Permit, Water Quality Certification - Clean Water Act

Table 4-1 – Summary of permits obtained for lower Kings River habitat enhancement projects.

4.1.3 Boulder Placement

In fall of 2002, the boulder project component of the Juvenile Trout Rearing Habitat Enhancement Project was implemented under Element #C-2002-8 of the fishery program. The boulder project occurred within a 7-mile river reach between the ACOE Bridge and the Avocado Split (Figures 4-1, 4-2). Five projects were completed in an upstream (reach 1) reach encompassing 5.6 linear miles of river from Pine Flat Dam downstream to Cobbles Weir and two projects were completed in a reach (reach 2) encompassing 4.1 linear miles of river from Cobble Weir downstream to Avocado Lake (Figure 4-1). More boulder projects occurred in River Reach 1 because they were located near a known trout spawning area and were believed to provide the most benefit to juvenile trout. Many of the fish habitat enhancement projects are located in the upper river reach. After young trout swim up out of the gravel, they are carried downstream by the current until they find suitable habitat with low velocity. This results in a natural downstream recruitment of juvenile trout from the upper river reach to the lower river reach.

Approximately 800 boulders were placed in the river among seven sites to enhance habitat for juvenile and adult trout (Figure 4-3). The emphasis of the project is to create survival and rearing habitat for juvenile trout, improve cover, and provide velocity refuges and feeding stations for both juvenile and adult trout. High river flows limit the availability of juvenile trout rearing habitat. Some boulders were placed near the edge of the river channel to provide habitat for juvenile trout during high flow periods. Other boulders were placed near the middle of the channel to provide habitat for adult trout during low flow periods. Boulders ranged in size from 2 to 4 feet in diameter (Figure 4-4).

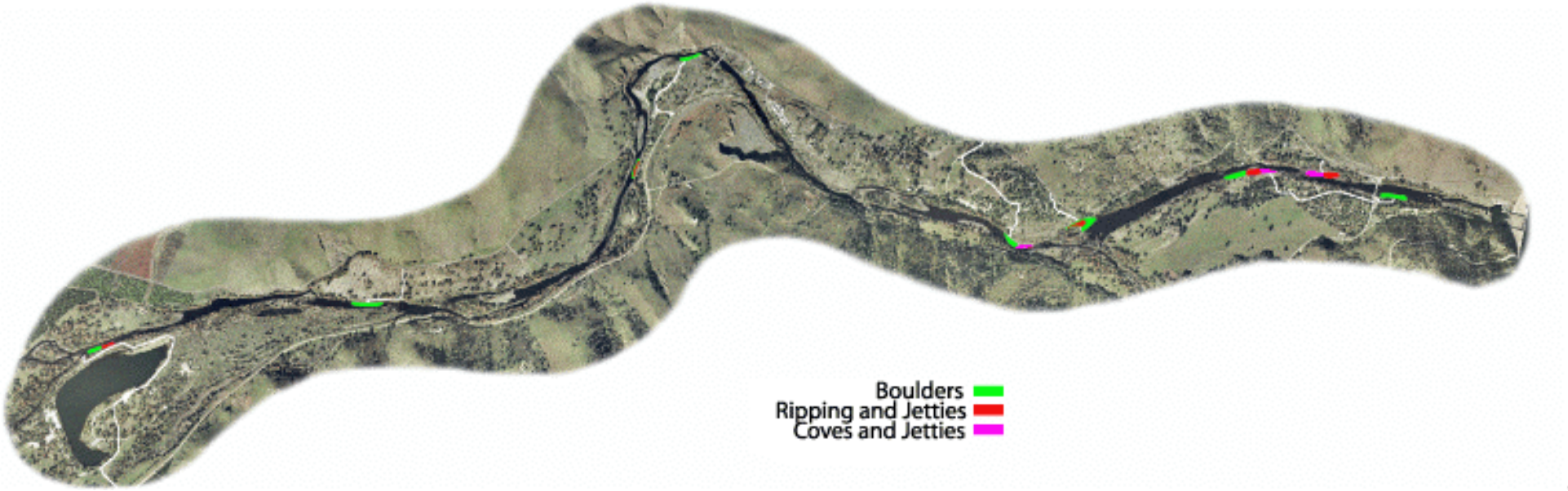


Figure 4-1 – Map showing location of habitat improvement projects on the lower Kings River. Pine Flat Dam is on the right and Avocado Lake is on the left.

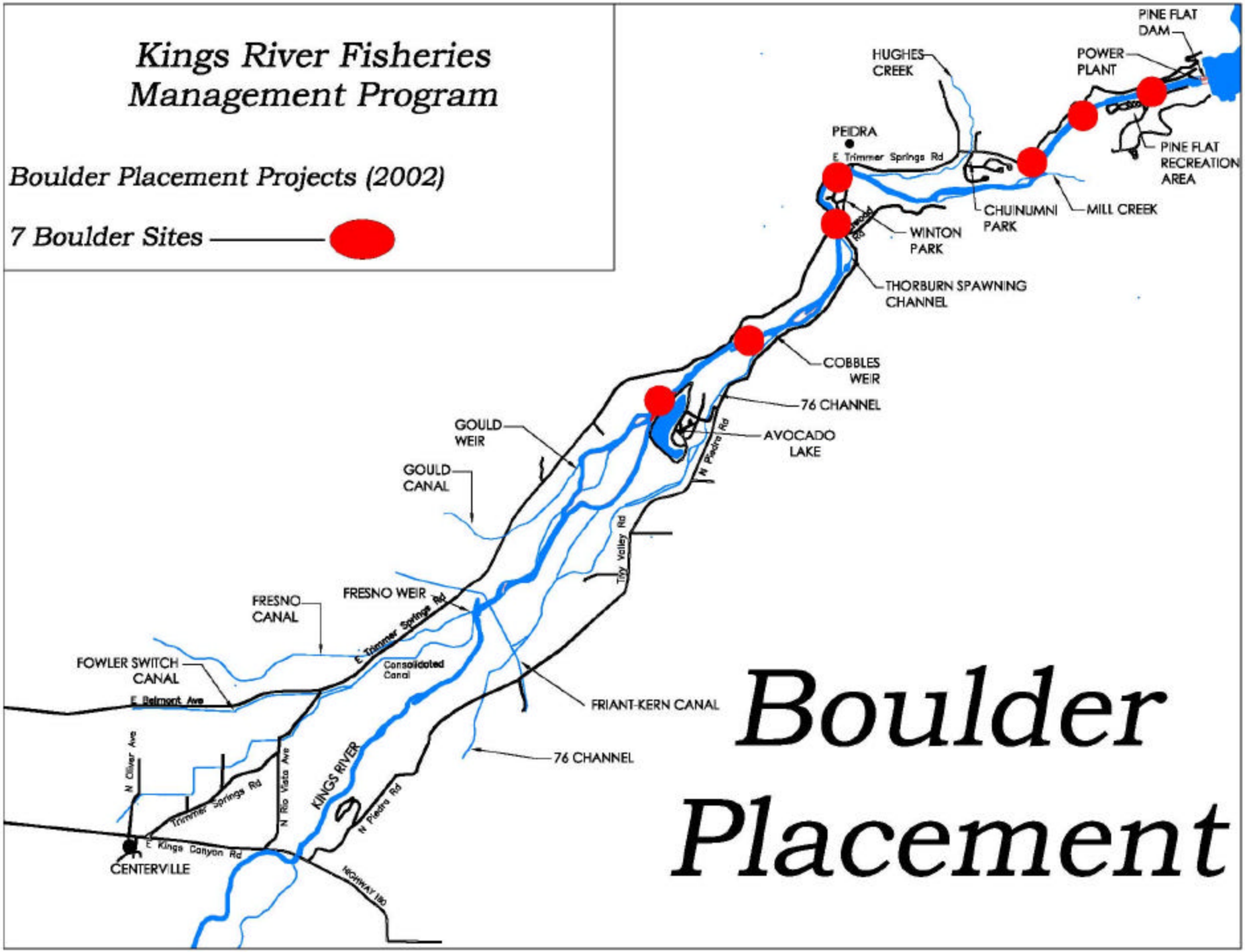


Figure 4-2 – Boulder placement sites on the lower Kings River

Figure 4-3 – Placement of boulders in the lower Kings River.

Figure 4-4 – Completed boulder project near Winton Park.

4.1.4 Construction of Coves and Jetties

One of the limiting factors for young trout in the lower Kings River is the lack of escape cover for trout to avoid high velocity irrigation releases. These flows generally occur between March and September. Native rainbow trout (trout historically present) spawn in the spring, probably between late March to early May. Trout fry swim up out of the gravel 2-3 weeks later, depending on water temperature, where they are subjected to the high water velocities associated with irrigation releases. Fry (< 2 inches) typically concentrate in shallow waters along the bank and prefer low water velocities (0.04-0.82 ft/sec). Juvenile fish (2-4.7 inches) occur in deeper and faster water (0.33-0.98 ft/sec) and usually can be found among rocks and other cover (Moyle 2002). There is also a hatchery strain of rainbow trout (probably Coleman strain) that have been selected over time by hatchery personnel to spawn in the fall that have been planted in the lower Kings River. This was done so that catchable sized trout would be available to anglers year round. Some of these stocked trout have survived and become established (reproducing) in the lower river and are considered to be wild trout (not native to the drainage, but reproducing in the wild). Some of these fall spawning wild rainbow trout have grown to more than 5 pounds. They have been observed spawning in the river in December and January. Fry resulting from this spawn were observed using the shallow backwater areas near the streambank in March and April. They use submerged rocks, tree trunks, vegetation and other habitat along the bank as cover.

Much of the Kings River channel, especially in the upper reach (Pine Flat Dam to Cobbles Weir), is relatively straight and lacks pocket water or adequate habitat to provide slow water refuges needed by young trout. As a result, the TSC believes juvenile trout produced in the river are likely swept downstream during the high flow period (March through September). There is a need to develop cover habitat and low velocity refuge areas where young-of the-year trout can escape the high velocities in the river. Coves and jetties have been used on a limited basis in northern California and Oregon on anadromous streams to improve and enhance juvenile rearing habitat (Scott Downey, CDFG, Personal Communication). In fall of 2002, the coves and jetties project component of the Juvenile Trout Rearing Habitat Enhancement Project was implemented under Element #C-2002-8 of the fishery management program. The coves and jetties projects were constructed within a 3-mile river reach between the ACOE Bridge and Choinumni Park (Figures 4-1, 4-5). The coves and jetties were located near a known trout spawning area to provide habitat benefit to these juvenile trout. Approximately 30 coves and jetties (Figures 4-6, 4-7) were built in the river at three sites to enhance habitat for young-of-the-year trout. The coves and jetties were built along the riverbank to provide low velocity habitat for young-of-the-year trout during high flow periods. The upper end of the coves was located at the high water mark when flows in the river are at 5,000 cfs. Coves are approximately 15 feet in length, 10 feet in width, and the bed was gradually sloped towards the river. The jetties were built from excavated cobble material, triangular in shape, and approximately 20 feet in length, 10 feet in width, and 2 feet in height. Tree root-wads were anchored at the terminal end of the coves to provide escape cover from predators.

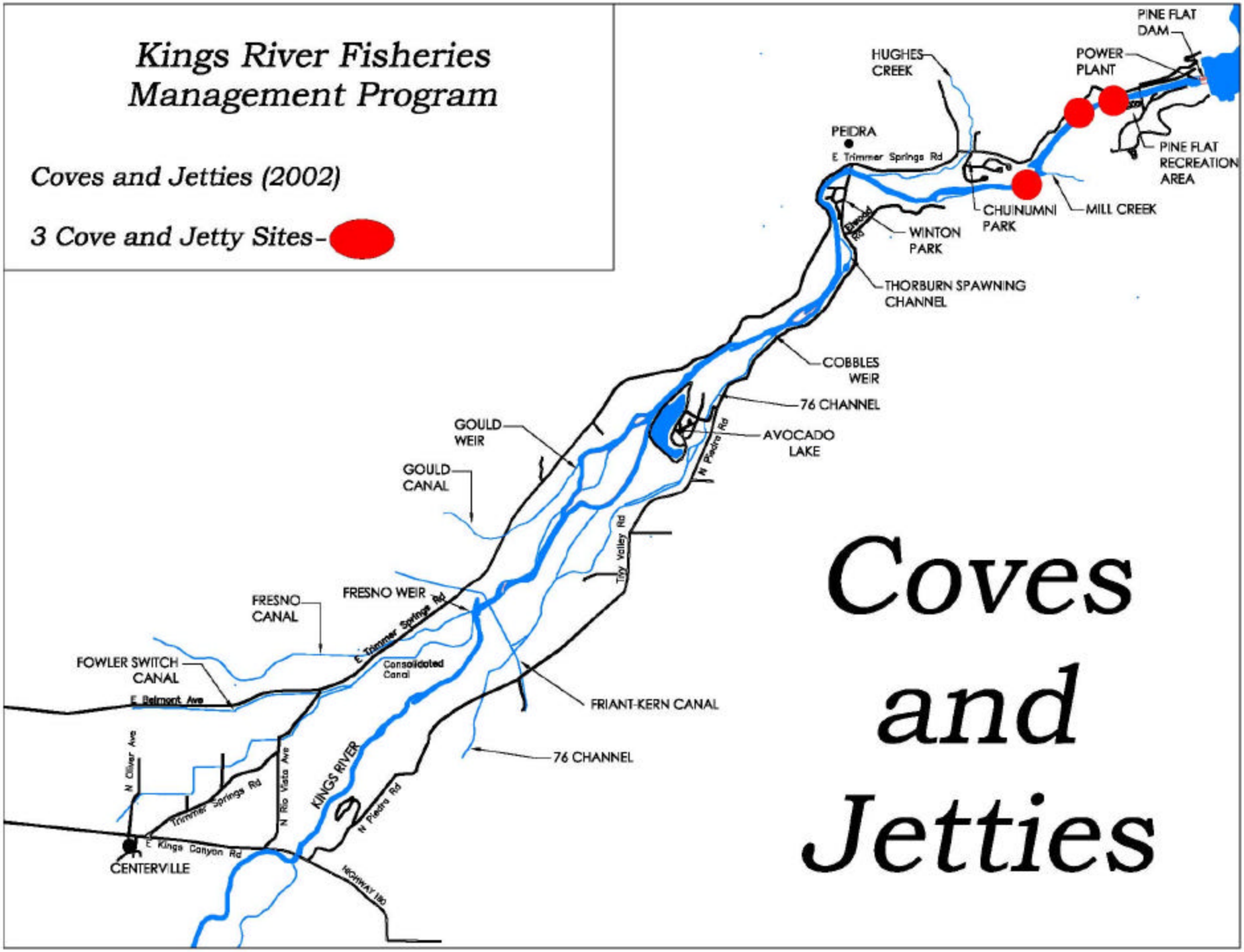


Figure 4-5 – Cove and jetty projects on the lower Kings River.

Figure 4-6 – Construction of cobble jetties in the lower Kings River.

Figure 4-7 – Completed coves and jetties near the Pine Flat Recreation area.

4.1.5 Channel Ripping

The TSC believes that a limiting factor to trout and aquatic insect production in the lower Kings River is the lack of interstitial spaces in the cobble and gravels that compose the channel bottom of the Kings River downstream of Pine Flat Dam. Pine Flat Dam blocks the downstream recruitment of gravel needed for spawning (Kondolf 1997). High water velocities move smaller sized gravel particles downstream leaving only the large (4-6 inch diameter) cobble (Trihey et al. 1992). Most of the space between these cobbles is filled with sand and fine–grained sediment, reducing habitat suitability for both fish and aquatic insects. The loss of interstitial spaces among gravel and cobble is important because it reduces cover habitat and areas where small fish or aquatic insects can hide to avoid predation and the high velocity irrigation flows. Mechanical ripping helps open gravel and reduces armoring thereby increasing the availability of interstitial spaces within the substrate.

In fall of 2002, the channel ripping and jetties test project component of the Juvenile Trout Rearing Habitat Enhancement Project was implemented under Element #C-2002-8 of the fishery management program. Five river reaches (Figures 4-1, 4-10) were ripped with a two-tooth bulldozer (Figure 4-8) to enhance habitat for juvenile trout and aquatic insects. Ripped areas were approximately 40 feet wide and ranged in length from 360 to 1200 feet (Figure 4-9).

The channel ripping project occurred within a 7-mile river reach between the ACOE Bridge and the Avocado Split (Figure 4-1). Four sites were ripped within the reach from the dam to Cobbles Weir in addition to one site in the reach from Cobbles Weir to Avocado Lake (Figure 4-10). More sites were ripped between the dam and Cobbles Weir because they were located near known trout spawning areas and would provide the most benefit to juvenile trout.

Figure 4-8 – Channel ripping of the lower Kings River.

Figure 4-9 - Completed channel ripping project near Winton Park.

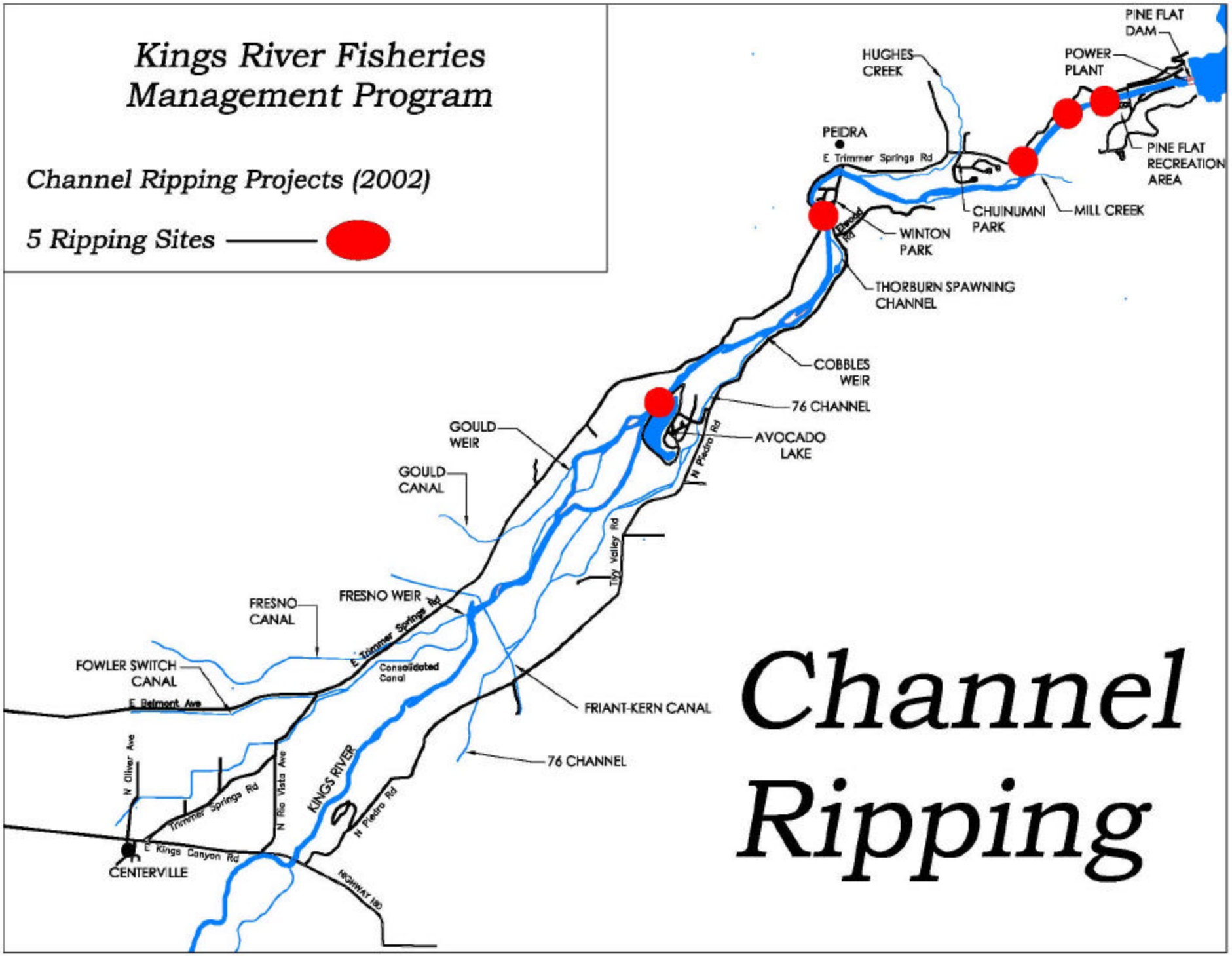


Figure 4-10 – Channel Ripping sites in the Lower Kings River.

4.1.6 Addition of Spawning Gravel

Section 1(f) of the Framework Agreement - Funding / Projects discusses fish habitat improvements to enhance fish and wildlife resources in the lower Kings River. The addition of spawning gravel to the lower river was identified by the TSC as a habitat enhancement action to create additional spawning opportunity for trout and enhance the habitat for aquatic insects.

The addition of gravel is intended to increase the spawning habitat available for trout in the lower Kings River. The additional gravel may also increase the macroinvertebrate population available as a food resource for juvenile and adult trout and other fish species. Macroinvertebrates use the interstitial spaces, currently lacking in many river sections, as cover to escape predation and the high velocity scouring irrigation flows. Young fish may use these spaces for the same purpose. Spawning gravel was placed in the main channel in October 2002 by dumping the pre-washed gravel in high water velocity areas and allowing the river to distribute the gravel downstream during high flows. Heavy equipment was used to spread the gravel as needed (Figure 4-11). Gravel ranged in size from 1/4 to 1 1/2 inch (natural-rounded). The depth of the gravel depends on the location where it collects, although the recommended depth of gravel for trout utilization is between 13 to 18 inches. Three spawning gravel deposit sites were identified based on heavy equipment access. These sites included: site 1) downstream of the ACOE Bridge; site 2) upstream of the Mill Creek and Kings River confluence; and site 3) upstream of the Winton Park boulder project (Figure 4-13).

In fall of 2002, the Gravel Placement Project was implemented under Element #C-2002-3 of the FMP. Approximately 750 cubic yards of pre-washed, spawning size gravel was placed in the river among three sites to enhance habitat for adult trout and insects. The gravel was spread over an approximately 80 x 80 foot area and was about 12 to 20 inches in depth (Figure 4-12). The gravel projects occurred within a 4-mile river reach between the ACOE Bridge and Winton Park (Figure 4-13). It is important that the gravel be placed high in the watershed since it will work its way downstream over the years. How many years this will take is not known, but is part of an ongoing monitoring study (Section 6.2.5). The gravel augmentation projects were located near known trout spawning areas and in locations where the gravel would wash downstream into suitable habitat areas.

Figure 4-11 - Placement of spawning gravel in the lower Kings River.

Figure 4-12 - Completed spawning gravel placement project near the Army Corps Bridge.

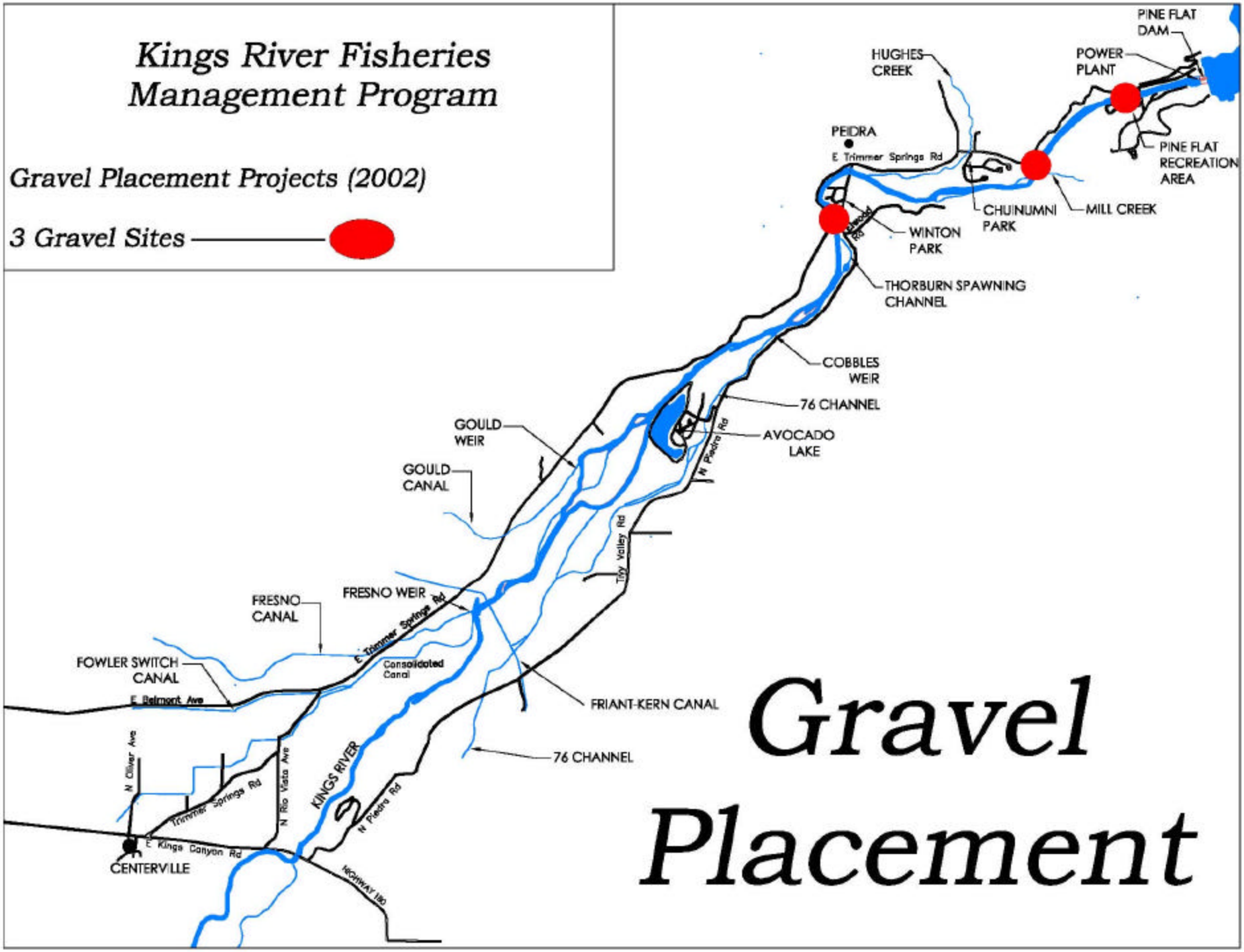


Figure 4-13 – Gravel Placement projects on the lower Kings River.

4.1.7 Thorburn Spawning and Rearing Channel

Maintenance activities at the Thorburn Spawning and Rearing Channel were conducted under Element #M-2002-1 of the 5-year plan. During 2002-2003, minor maintenance activities in the channel including head gate cleaning, K-rail-Beaver dam removal, a final herbicide application to eliminate Arundo (false bamboo) and vegetation control along the nature trail and road were completed. Young oak trees were watered and maintained during summer and fall of 2002. The channel is functioning properly, no significant erosion is occurring, and fish habitat and flow control structures are stable.

Several tasks were completed in 2002-2003 for the Wildlife Habitat Incentives Program-Natural Resources Conservation Service Cost Share Grant at the Thorburn Channel. Activities were conducted under Element #C-2002-6 of the 5-year plan. Tasks include installation of a drip irrigation system along the channel, planting of 200 trees and bushes (Figure 4-14 and 4-15), building and posting of ten Wood Duck nest boxes (Figure 4-16), installation of approximately 40 cobble wing deflectors (Figure 4-17), and chemical treatment of a weedy upland pest - Tree of Heaven. The original trash rack located at the headworks of the channel was also modified to allow for larger debris to pass into the channel and to reduce maintenance requirements for trash rack cleaning and to improve flow into the channel.

Figure 4-14 – California Conservation Corps members installing drip irrigation system to irrigate newly planted trees.

Figure 4-15 – California Conservation Corp placing protective cage around newly planted tree.

Figure 4-16 - Jack Thorburn with Teneya Middle School students preparing to install wood duck nest boxes.

Figure 4-17 - Completed cobble wing deflector in the Thorburn Spawning Channel.

4.1.8 Fish Passage Evaluation

Section G (1)(f) of the Framework Agreement - Funding / Projects discusses fish habitat improvements such as the creation of spawning sites and fish passage facilities to enhance fish and wildlife resources in the lower Kings River. The purpose of fish passage is to allow fish, with emphasis on rainbow trout, to move freely throughout the lower Kings River system to:

1. Access spawning and rearing areas;
2. Access side channel habitat to avoid high irrigation and flood releases;
3. Prevent stranding and mortality in side channels;
4. Access other river reaches for better food, space, and flow conditions; and
5. Access colder water in upstream areas when stressful warm water temperatures occur in downstream reaches.

In 1991-1992, Trihey et al. (1992) identified potential fish passage barriers in the lower Kings River. In 1997, KRCD prepared a preliminary assessment of potential fish passage barriers (KRCD 1997). In February 1999, Mr. George Heise, a CDFG engineer and expert on fish passage, toured potential fish passage barriers with KRCD, CDFG, and KRWA staff and discussed possible options and costs for structures that would improve fish passage at various locations. KRCD has also prepared reconnaissance fish passage reports for Mill Creek Gaging Weir, Gould Weir, and the Dennis Cut Headgate (KRCD 1999a, b, c).

In developing the 2002-2003 priorities for habitat enhancement projects the TSC considered and discussed barriers and impediments to fish movement within the lower Kings River and the potential for developing fish passage facilities. After considering both fish passage and other habitat enhancement opportunities, the TSC decided to defer consideration of fish passage projects to a later date and to concentrate activities during 2002-2003 on habitat enhancement projects, such as boulder placement, gravel augmentation, construction of coves and jetties, and projects within the reservoir this year.

4.1.9 Investigation Into Gifts And Grant Opportunities

During the preceding program year, an avid Kings River fisherman named Mickey Masini passed away. His family requested that in lieu of flowers that his friends make contributions to the Kings River Fishery Management Program. Donations totaling $350 have been made to the fishery program in his name. KRWA is acting as fiscal agent for these monies until they are allocated to fishery habitat enhancement projects within the lower river.

In response to the opportunities for the fishery program to accept donations and grants, consideration has been given to creating a tax-deductible account (mechanism) to encourage further donations and/or grants. TSC members contacted organizations and

individuals with expertise in receiving and administering gifts and grants (tax-deductible or not). Implications of the different mechanisms to the program and its participating agencies were evaluated. Based on results of these inquiries the TSC will prepare a summary report on the options available and a possible recommendation for consideration by the ExCom in the future.

4.1.10 Advanced Planning and Project Scoping

Advanced planning and project scoping activities by the TSC have been conducted in support of the non-capital element #N-2002-6, continued development of the 5-year plan. It is anticipated that as future capital projects such as low flow channels are developed, technical expertise outside that contained on the TSC (i.e. fluvial geomorphologists, engineers, and/or other professional specialist) will be required during the technical reconnaissance phase of element development. Advanced project planning activities include reconnaissance level studies to select potential projects and programs, locations, preliminary designs, and evaluation of environmental impacts and floodway concerns. Based on results of the advanced planning reconnaissance studies, the TSC identifies beneficial and feasible projects for inclusion in the 5-Year Plan and a recommendation for ExCom approval to complete a final design, obtain the necessary permitting and construct, where applicable, the final program or project.

Particular attention in the advanced planning feasibility studies is given to concerns regarding a project or program's impacts to flood control and how projects and programs may impact or be impacted by fluvial processes. The advanced project planning and scoping includes; (i) preliminary design of projects or programs, (ii) evaluating potential impacts to existing river operations, (iii) establishing preliminary cost estimates, (iv) identifying fishery benefits, and (v) determining what permitting may be necessary. Advanced planning and scoping is an ongoing TSC activity.

4.1.11 River Habitat Typing Report and Map

As part of project planning by the TSC, information was needed to characterize and map existing fish habitat within the lower Kings River. This was Element #N1 in the Program Year 2002-2003 5-Year Plan. Two CDFG biologists from northern California, with the assistance of KRCD biologists, conducted a Level IV habitat typing and mapping survey of the Kings River from the Highway 180 Bridge approximately 12 miles upstream to Pine Flat Dam in January 2000. The habitat inventory conducted in the Kings River follows the methodology in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al, 1998). There are four levels of classification used to describe physical fish habitat. Each higher level includes more descriptive categories of habitat types. Level IV is the highest level of classification and includes the causes of pool formation. Other habitat classifications are further subdivided, which is lacking in lower levels of habitat classification. The results of this survey only apply to the low flow conditions encountered during the survey period. The habitat will change under different flow conditions.

The inventory uses a method that samples approximately 10% of the habitat units within the survey reach. All habitat units included in the survey are classified according to habitat type and their lengths are measured. All pool units are measured for maximum depth, depth of pool tail crest (measured in the thalweg), and dominant substrate composing the pool tail crest, and embeddedness. Habitat unit types encountered for the first time are measured for all the parameters and characteristics on the field form. Additionally, from the ten habitat units on each field form page, one is randomly selected for complete measurement.

There are nine components recorded on a standard data form: 1) stream flow, 2) channel type, 3) water and air temperature, 4) habitat type, 5) embeddness, 6) shelter rating, 7) substrate composition, 8) canopy cover, and 9) bank composition and vegetation. The data is summarized and produces a series of table and graphs showing the various characteristics of the river (Beal et al. 2004). When viewed together, the results of the habitat typing describes the percent of the various habitat components present that are know to be advantages for salmonids. Also, recommendations are made to improve components that are low in value or lacking.

Channel Type

While the results of the survey are too extensive to include in this document, a brief summary follows. The Kings River in the survey reach is a DA3 channel type, which means it is narrow and deep multiple channels, with expansive well vegetated floodplains and associated wetlands (Rosgen 1994). These types of channels have very gentle relief with highly variable sinuosities, stable streambanks, and cobble dominated substrates.

Habitat Type

Fifteen Level IV habitat types were identified. The most frequent habitat types by percent occurrence were low-gradient riffle, 34%; run, 25%; and mid-channel pool, 18%. Based on percent total length, mid-channel pool made up 41%, run 19%, and low-gradient riffle 16%.

A total of 106 pools were identified. Main channel pools were the most frequently encountered, at 58%, and comprised 71% of the total length of all pools. Pool quality for salmonids increases with depth. Eighty-one of the 106 pools (76%) had a depth of three feet or greater.

Embeddedness:

The depth of cobble embeddedness was estimated at pool tail-outs. Of the 106 pool tail-outs measured, 1 had a value of 1 (1.0%); 6 had a value of 2 (5.7%); 35 had a value of 3 (33.0%); 8 had a value of 4 (7.5%); and 56 had a value of 5 (52.8%). On this scale, a value of 1 indicates the highest quality of spawning substrate. Additionally, a value of 5 was assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, bedrock, or other considerations. The breakdown of dominant substrate

composition for the 56 pool tail-outs that had a embeddedness value of 5 were as follows: 62.5% large cobble, 26.8% small cobble, 8.9% bedrock or cement, and 1.8% small gravel.

Shelter Rating

Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation or reduced water velocities so fish can rest and conserve energy and allow separation of territorial units to reduce density related competition. The shelter rating is calculated for each fully described habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types (i.e. undercut banks, bubble curtain, boulders, etc.). In the Kings River, a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) was assigned according to the complexity of the cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream reach.

A shelter rating was calculated for each habitat unit and expressed as a mean value for each habitat type within the survey using a scale of 0-300. Riffle habitat types had a mean shelter rating of 6, flat-water habitat types had a mean shelter rating of 5, and pool habitats had a mean shelter rating of 7. A pool shelter rating of approximately 100 is desirable. Of the pool types, the scour pools had the highest mean shelter rating at 9. Backwater pools had a mean shelter rating of 7.

Primarily boulders, in all habitat types, provide the relatively small amount of cover that exists. Additionally, small woody debris contributes a small amount. Log and root wad cover structure in the pool and flat-water habitats would enhance both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition.

Substrate Composition

Small cobble was the dominant substrate observed in 47% of pool tail-outs while large cobble was the next most frequently observed substrate type, at 28%.

Canopy:

The mean percent canopy density for the stream was 4%. In general, revegetation projects are considered when canopy density is less than 80%. The Kings River is wide so overhead cover is difficult to provide. Additional trees would provide needed cover.

Bank Composition and Vegetation:

The percentage of right and left bank covered with vegetation was moderate, at 62%, and 60%, respectively. The mean percent left bank vegetated was 60.1%. The dominant elements composing the structure of the stream banks consisted of 0.59% boulder, 45.29% cobble/gravel, and 54.12% sand/silt/clay. Deciduous trees were the dominant vegetation type observed in 66.47% of the units surveyed. Additionally, 20.0% of the units surveyed had brush as the dominant vegetation type, and 13.53% had grass as the dominant vegetation.

RECOMMENDATIONS

1) The Kings River should be managed as a mixed fish production stream;

2) Increase cover in the pools and flat-water habitat units. Large boulders provide most of the existing instream cover. Adding additional high quality complex cover is desirable;

3) Increase the canopy on the Kings River by planting willow, alder, native riparian dependent trees and oaks along the stream where shade canopy is not at acceptable levels. The reaches above this survey section should be inventoried and treated as well;

4) There are river reaches where the stream is being impacted from cattle trampling and grazing in the riparian zone. Actions to protect the riparian areas should be discussed with the landowners and protective measures developed if possible.

4.1.12 Aerial Photography

There was a need for low elevation, high resolution aerial photographs to identify fishery habitat enhancement opportunities. This is Element #C10 in the Program Year 2003-2004 5-Year Plan. A second set of aerial photographs were taken on March 1, 2003. The photographs cover an area from Pine Flat Dam to approximately Reedley. The flow rate of the river at the time the photographs were taken was approximately 250 cfs. The first set of photographs was taken in December of 2001 when the flow rate was approximately 100 cfs. The results of the element are a set of prints as well as a set of digital photographs. These have proven to be extremely useful for project planning and implementation. Analysis is underway to quantify water surface area under the two flow regimes.

4.2 PINE FLAT RESERVOIR

The Framework Agreement's "Exhibit A" Aquatic Resource Enhancement Goals for the Lower Kings River and Pine Flat Reservoir states that "within the constraints imposed by water operations and without creating a risk of future endangered species conflicts, (the program will) provide in-reservoir habitat improvement for warm-water fish. Habitat enhancement projects implemented within the reservoir during 2002-2003 were implemented under Element #C-2002-7: Reservoir Projects and included 1) seeding of vegetation to provide a food source and cover for juvenile fish within the inundation zone, and 2) the placement of structural anchors (gabions) for anchoring manzanita within the reservoir to provide cover and improve fish habitat.

Grass seeding was the primary focus of the reservoir fishery habitat enhancement efforts during 2002-2003, but other vegetation types were also used. Combinations of plants were seeded at various locations within the fluctuation zone of the reservoir. Plant choices included: 1) annual grasses, such as wheat and barley, 2) perennial grasses, 3) native grasses, and 4) lupine and lotus planted in a variety of combinations and individually. Planting sites included areas in the vicinity of Deer Creek, Island Park, and Edison Point near Lombardo's launch ramp (Figure 4-12).

Other reservoir projects completed during 2002-2003 were directed at increasing the quantity of structural cover available for use by fish by installing permanent structural anchors in the reservoir fluctuation zone. Structural anchors were placed perpendicular to the waterline and run up and down the slopes. Brush structures were then cabled to the anchoring system. Locations and the design of habitat enhancement projects within the reservoir were reviewed and approved the U. S. Army Corps of Engineers (COE). Habitat enhancement projects completed in Pine Flat Reservoir during 2002-2003 as part of the fishery program are briefly described below.

4.2.1 Grass Seeding

4.2.1.1 Annual Grasses

Deer Creek

The site selected at Deer Creek consisted of several rocky areas each with slight soil erosion problems. A triple winter grass seed mixture (winter wheat, barley, and rye) was applied to the shoreline within the reservoir fluctuation zone in late fall-winter 2002 (Figure 4-18).

The site was divided into three treatments: 1) a control where only grass seed was planted, 2) a site which received a standard fertilizer application; and 3) a site that received a time-release fertilizer. The grass grew taller in the two areas receiving fertilizer when compared to the control. There was no apparent difference between the two types of fertilizers (Figure 4-19 and 4-20). During project planning, concern was expressed by some members of the public that the fertilizer would result in a localized algal bloom. Observation following completion of the project did not detect an increase in algae in the area following inundation. This resulted in excellent seed germinations and growth, resulting in excellent habitat for juvenile fish.

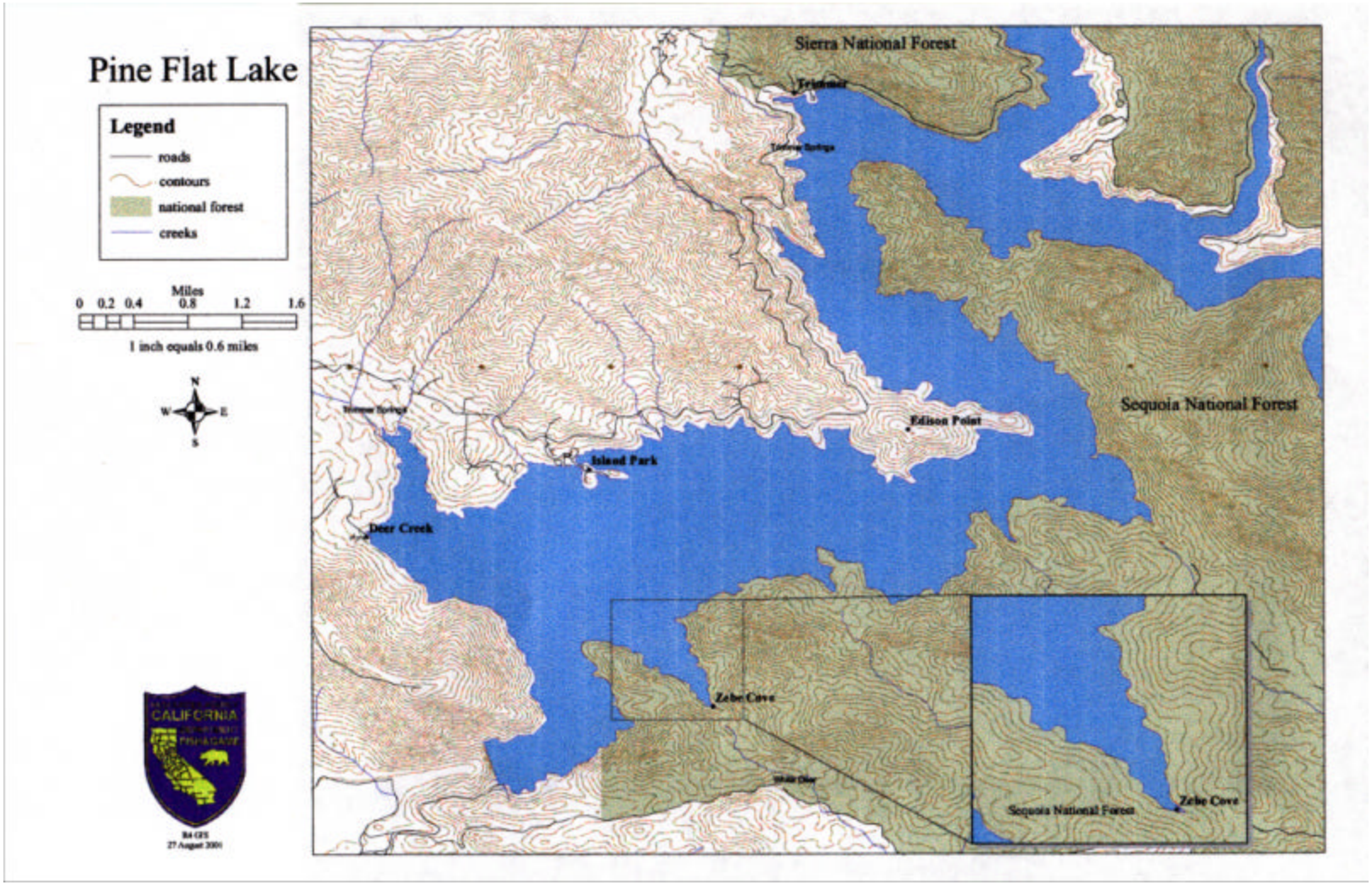


Figure 4-18 – Map of Pine Flat Reservoir showing the location of habitat improvement projects.

Figure 4-19 – Deer Creek study area. The far area received no fertilizer and the closer area received a general fertilizer.

Figure 4-20 - Deer Creek planting station showing the area receiving the timed release fertilizer location to the left of center.

Island Park

The site selected consisted of sandy terraced slightly eroded soil, which was divided into three treatments identical to the Deer Creek experiment. Grass seed was applied during the late fall-winter at Island Park. Again the grasses grew best where fertilizer had been applied (Figures 4-21, 4-22; 4-23 and 4-24). Approximately 4.5 acres of lake shoreline was planted with a combination of barley, oats, and wheat seed mixture at about 100 pounds per acre (450 pounds total). The site was split into 3 separate treatment areas: 1) area 1 received no fertilizer; 2) area 2 received an application of fertilizer that was a one time release fertilizer; and 3) area 3 received a fertilizer that was designed to release fertilizer over a 6 month period. Areas 2 and 3 each received 1,000 pounds of fertilizer each distributed equally over the area.

Figure 4-21 - Island Park winter wheat planting area. The area in the center of the photograph received no fertilizer. This photo was taken from Lombardo's launch ramp.

Figure 4-22 - CCC providing soil preparation at Island Park seeding area. Habitat structures of discarded launch ramp floats are seen at the left center of the photograph.

Figure 4-23 - Winter wheat beginning to emerge after a two-week period highlighted by good rains in March.

Figure 4-24 - Winter wheat emerging with a small amount of Bermuda grass in a slightly eroded area.

Island Park Launch Ramp – Toward Lake View

Approximately 4.5 acres of lake shoreline were planted in the same manner as the sites at Island Park.

Lombardo's Marina

The area selected for seeding is located just west of Lombardo's launch ramp and is fully visible from the Island Park experimental area (Figure 4-25). Grass seed was applied during the late fall-winter near Lombardo's launch ramp. Only grass seed along with fertilizer was applied to this area. Grasses grew well and were well formed and dense when covered by the rising lake water levels during late spring.

Figure 4-25 - A view from Island Park. Lombardo's study area is to the left of the house boats in the marina.

4.2.1.2. Perennial Grasses

Island Park – Erosion Control Site

Figure 4-26 – Heavily eroded area at Island Park launch ramp which was planted for a second year with Bermuda grass. The Island Park Project 2 study area is located to the left of the highly eroded area.

Island Park is an area of the lake is badly eroded and the thought was that establishing a ground cover of perennial Bermuda would reduce the soil erosion (Figure 4-26). The Island Park site was seeded in 2001 using perennial grass seed. This site received about 350 pounds of Bermuda grass after many of the gullies were treated by hand raking to minimize the erosion that had occurred on the site. The Island Park area was reseeded for the second year in 2002. None of the Bermuda grass seed was successful in establishing new root systems. The reason for this is unknown, but the effort will most likely not be repeated at this site.

4.2.2 Seed Collection for Nursery Stock

The purpose of this project is to provide rooted shrubs and bushes for outplanting in the fluctuation zone of Fine Flat Reservoir. Once established, the plants will be able to withstand some inundation by reservoir water and provide habitat for warmwater fish.

A nursery was constructed at Pine Flat Lake to propagate vegetation in early 1990's. Over the years the nursery has deteriorated and finally was abandoned. This project would reestablish and upgrade the nursery so that selected plant species could be propagated for planting within the fluctuation zone at Pine Flat reservoir. Plant species approved by the U.S. Army Corps of Engineers (COE) for propagation at the nursery include buttonbush, native lupines and lotuses.

Activities completed July 1, 2002-June 30, 2003: One day of seed collection was accomplished by 11 members of the California Conservation Corps (CCC). Seed bundles were collected for a *Lupinus* sp., a lotus plant *Lotus scoparius* and a native vetch, *Vicia* sp. Plans were made to collect seeds from buttonbush also but this did not happen. The seed pods from the bush lupine were easy to collect and were even offered to us by residents that had propagated the bushes for many years. The lotus seeds were collected from plants near Deer Creek and identified by Fish and Game Associate Botanist Mary Ann McCrary. The vetch seeds were also collected between Deer Creek and Island Park and were identified by Associated Fisheries Biologist James Houk. We were unsuccessful in preparing the seeds for culturing. Some of the seeds were provided to a science student in a middle school for a science project. The student tested growth rates compared between potting soil and actual soil from Pine Flat Reservoir and noted germination rates and growth rates for all three types of seeds. The only seed that germinated were the lupine seeds and they grew best in soil treated with fish meal. This study may be expanded and improved for next year depending on availability of personnel and funding.

Figure 4-27 - Common vetch intertwining with lotus plants. These are two of the species from which we selected seed for cultivation.

During 2002-2003, seed from three plant species were collected by the California Conservation Corps (CCC) for use in habitat projects within the reservoir. All the seeds were subjected to experimentation in the science fair arena with only the *Lupinus* sp. seeds germinating at all. Both the lotus and the vetch seeds need a stimulus in order to germinate. The seeds grew well in soil collected at Pine Flat Reservoir (Figure 4-27) but did not seem to benefit from fertilizer. Fishmeal protein was added and increased growth rates significantly (Figure 4-28). Further testing is planned to identify plant species suitable for planting within the reservoir inundation zone to improve habitat quality, availability, cover and foraging areas for warmwater fish species.

Figure 4-28 - The bush lupine *Lupinus* sp., which grew well in laboratory testing.

4.2.3 Adding Fish Habitat to Pine Flat Reservoir

Gabions were purchased by the U. S. Army Corps of Engineers for installation within the reservoir fluctuation zone to enhance cover habitat for warmwater fish. These were transferred to the old, now closed, Sycamore Canyon Campground to be filled with cut and trimmed manzanita (Figure 4-29). In previous year's the Miramonte Fire Crews cut the manzanita and filled the gabions. The Miramonte Fire Crew was not available during the 2002-2003 winter period. The CCC was contracted for the 2002-2003 fishery program to cut the manzanita, fill the gabions, transport the gabions to Trimmer Marina, transport the gabions to selected locations and then anchor a cabling system to secure the gabions within the reservoir fluctuation zone (Figure 4-30). All the work this year was completed except for the transferring and anchoring of the gabions in selected locations. This will be completed when the water levels recede in the fall 2003 if personnel and funding are available.

Figure 4-29 - Construction of gabions at Sycamore Canyon campground.

Figure 4-30 - Manzanita filled gabions being readied for transport to Sycamore Cove.

4.3 Summary and Discussion

The TSC is pleased with the 2002-2003 habitat improvement projects constructed in Pine Flat Reservoir and on the lower Kings River. The scientific literature supports the additional of spawning gravel, channel ripping, and addition of boulders to enhance habitat quality and availability for trout and therefore these types of projects should be continued on an annual basis. Construction of coves and jetties are considered experimental and must be monitored for several years to determine if they are effective at providing habitat for young trout and other desired species before additional structures are built.. Other habitat improvement techniques are continuing to be investigated by the TSC and their suitability for the lower river determined as part of the ongoing planning and development of priorities for inclusion in the 5-Year Plans.

The habitat improvement activities undertaken in the reservoir are well documented as effective tools for fishery improvement purposes. Habitat enhancement projects conducted within Pine Flat Reservoir, including grass seeding and construction of anchoring systems for additional cover habitat, provided promising results. Grass seeding within the reservoir inundation zone, planted during the late fall-winter, became well established and is thought to provide improved foraging and cover opportunities for juvenile fish within the reservoir during the spring. The addition of fertilizer proved to be successful in increasing the growth rate of grass that is planted with the reservoir. Additional investigation of perennial plant species for use in reservoir habitat enhancement is ongoing. Providing additional cover habitat for warmwater species has been identified by the TSC as being biologically beneficial and is recommended to continue as part of the fishery program. These are projects that need to continue on an annual basis in order to be effective and compensate for decrease warmwater fish production as the reservoir ages. However, the CDFG Reservoir Biologist, who led these activities, has been reassigned to another high priority project and will no longer be available to work on this project. We are hopeful the ACOE will take the lead on these projects in the future.

Physical Changes to Habitat Enhancement Projects

An integral part of the Fisheries Management Program is to monitor its projects. Project monitoring helps insure that future programs can be implemented to maximize project benefit. In November 2003, assessments of the October 2002 projects were completed. Visual observations were made to assess changes to physical characteristics of habitat projects after experiencing a high flow irrigation season. This assessment covered all the Juvenile Habitat Projects: ripping, coves and jetties and boulder placement. The impacts and results of the Juvenile Habitat Projects are discussed below.

Coves and Jetties:

The coves and jetties showed the most dramatic change of all the projects. Most of the change can be attributed to high flows and a small amount of vandalism. Notable changes included loss of woody debris, broken eyelets and settled jetties.

The loss of woody debris was evident at all cove and jetty sites. It is likely that woody debris came loose from nuts loosening from the u-bolts used to clamp the stainless steel cable. It is

anticipated that a reduction in loss of woody debris can be obtained through the use of thread-lock on the clamps. Water damage was also observed in two different manners; corrosion and fatigue. The corrosion occurred on the galvanized eyelets that eventually corroded enough that metal fatigue sheered them off at the base as opposed to the stainless steel eyelets that remain intact. It is recommended that eyelets be of ¼inch diameter stainless steel variety and have the least amount of visible shank above the base as possible. This will reduce sheer due to fatigue on the eyelets.

Vandalism is most evident at Pine Flat Recreation area where eyelets have been deliberately damaged. Vandalism was mostly in the form of complete removal of eyelets, evident from an inspection conducted one week after project installation, whereby several eyelets had been removed before the epoxy had set. One site showed an eyelet that had been deformed. It is unlikely that the eyelet had been deformed from natural causes.

The settling of the jetties from their original "block" style to a more "rounded" stable state was expected. The extent of the settling wasn't initially known. The width of the coves and the height of the jetties are adequate enough to allow the settling to occur without causing congestion in the coves. To reduce the settling that did occur, maintaining the use of the larger cobble material is recommended. Size and height of the coves and jetties is adequate.

Boulders:

The boulder project appears largely unchanged. A couple boulders that were in the main channel had moved a little, most likely due to settling. No changes to the design of the boulder projects recommended.

Ripping:

The ripped sites show a small to medium amount of expected change from October 2002. Notable changes include sediment settling and jetty stabilization. Observation of the project sites in general shows a low amount of "armoring" in areas with large cobbles (6" – 10" diameter) and a high quantity of armoring in areas with smaller material. By using the ripped material to create the jetties, small underlying rocks were exposed. These smaller rocks settled into a thin barrier during high flows. From a hydraulics standpoint, this causes the velocity near the channel bottom to increase. To increase the area where large cobbles occur, it is recommended that jetties not be created from material that has been ripped. Creating the jetties higher up the bank would decrease bank erosion. Short of the fore mentioned adjustment, no further changes are recommended.

Based upon results of the 2002-2003 habitat enhancement projects, and preliminary results of visual observations and data collected, the TSC is supportive of continued habitat enhancement activities that would include, but not be limited to, the following:

- Grass seeding within the inundation zone of Pine Flat Reservoir;

- Investigations of potential perennial plant species that may improve habitat conditions within the reservoir;

- Continued construction of anchoring systems and cover habitat to benefit warmwater fish species at various water depths within the reservoir;

- Continued placement of boulders and jetties to provide cover and velocity refuges within the lower river;

- Continued gravel augmentation and channel ripping to improve gravel quality as habitat for trout spawning and macroinvertebrate production;

- Continued exploration of donations and grants to help support habitat enhancement activities, and augment funds available from the Framework Agreement, as part of the fishery program; and

- Monitoring the physical habitat characteristics and fish use of coves and jetties as part of the monitoring program. Based on the results of this monitoring, determine if the construction of additional coves and jetties is desirable. Also, monitoring fish use earlier in the season (March through April) than done in 2003 (Section 6).

5.0 FISH STOCKING

5.1 INTRODUCTION

The stocking of fish in State waters is the responsibility of the California Department of Fish and Game. During the 2002-2003 reporting period, the allotted number of catchable size rainbow trout (76,000 fish) and subcatchables were planted in the Kings River between Pine Flat Dam and Fresno Weir. An additional 20,000 pounds of catchable sized trout were paid for by Framework Agreement funds and stocked in the lower river during 2002-2003. In addition, trout eggs were transferred to the lower Kings River for incubation and hatching. Kokanee salmon, catchable trout, and Florida strain bluegill were planted in Pine Flat Reservoir during 2002-2003. Fish stocking within the lower river and Pine Flat Reservoir is briefly discussed below.

5.2 RIVER

5.2.1 Whitlock Vibert Boxes

Section G1(j) of the Framework Agreement "Stocking Program" discusses trout stocking in the lower Kings River. Trout egg planting is conducted to augment the naturally spawned production of juvenile trout in the river in order to increase the trout population. Planting of trout eggs is a fast, efficient, and inexpensive way to increase the production of juvenile fish into the river and increase the overall trout fishery.

Whitlock Vibert Boxes (WVB) have been used for years as a means to hatch trout eggs in flowing water. The small plastic boxes (Figure 5-1) contain two chambers: an upper chamber which is 'charged" with about 500 eyed trout eggs, and a lower chamber where the sac fry drop after hatching and are held until they absorb the yolk sac and are able to pass between the plastic bars and swim up through the gravel and into the stream. Normally, the charged WVBs are buried in the stream channel in the gravel of a riffle. The eyed eggs normally hatch within a few days and the fry reach the swim-up stage in about 3 weeks, depending on water temperature.

While this has been an effective technique in the past, the large cobble that form the streambed and high irrigation flow releases of the lower Kings River during the spring and early summer rainbow trout spawning period, make it difficult to bury the WVBs in the channel. To help address these problems, streamside incubators were used in 2002-2003 as discussed below. The use of streamside incubators to hatch trout eggs is a technique developed by Trout Unlimited, a national angling and conservation organization.

5.2.2 Streamside Incubators

The streamside incubators consist of refrigerators that have been modified to hatch trout eggs (Figure 5-2). A series of baffles are installed to direct the flow of water through the refrigerators, which are laid on their backs adjacent to the stream (Figure 5-3). Water enters the upstream side of the refrigerator, flows through the baffles inside the refrigerator and over the charged WVBs and exits the downstream end and returns to the river. The exit has a baffle to make it more

difficult for sac fry to escape the refrigerator. The young trout have to have some swimming ability before they can navigate their way out of the incubator and into the river.

Figure 5-1 –Whitlock Vibert box being charged with eyed trout eggs.

Figure 5-2 – Early version of streamside incubator.

2000

Three streamside refrigerator incubators were constructed in 2000. KRCD staff constructed the first incubator box, and members of the PAG constructed the other two (Figure 5-2). KRCD staff located appropriate sites in the Avocado Side Channel for the boxes (Figure 5-3) and along with CDFG biologists and PAG members installed them. The boxes were successfully used to hatch 80,000 rainbow trout eggs in December 2000. Also in December 2000, 20,000 rainbow trout eggs were planted in the Thorburn Spawning Channel. Staff from all three agencies, along with members of the PAG and the public participated in planting the eggs.

2001

The incubator boxes were successfully used to hatch 100,000 rainbow trout eggs in December 2001. Sites included the Thorburn K-rail weir, a side channel upstream of Alta Weir, and the Avocado Side Channel near the Dennis Cut diversion. Some fry were collected from the incubator and were planted in other areas of the river in suitable backwater habitat. CDFG provided the eyed eggs at no charge to the fishery program. Volunteers assisted CDFG and KRCD biologists with charging WVBs and placing them in streamside incubators. Incubation and hatching was accomplished under low flow conditions. The design of the streamside incubators was modified to account for low hydraulic head, which resulted in the minimum flow of water through the boxes.

In January 2001, 80,000 brown trout eggs were planted directly in the river using artificially constructed redds, located upstream of the Mill Creek confluence (Figure 5-5). Also in January 2001, 20,000 brown trout eggs were planted in the Thorburn Spawning Channel.

2002

The three-streamside incubators were setup along the lower Kings River at three sites in November 2002 as was conducted in year 2001. On November 19, 2002 the WVB's were charged with 100,000 rainbow trout eggs (Highway strain) and placed in the streamside incubators. They began hatching within a few days. The young trout remained in the box for several weeks. Some trout were still in the incubator when the boxes were finally cleaned out. The overall successful hatching rate was between 85-95%. Also in 2002, planning for two permanent streamside incubators (Figure 5-6) which will be run by electrical power was conducted.

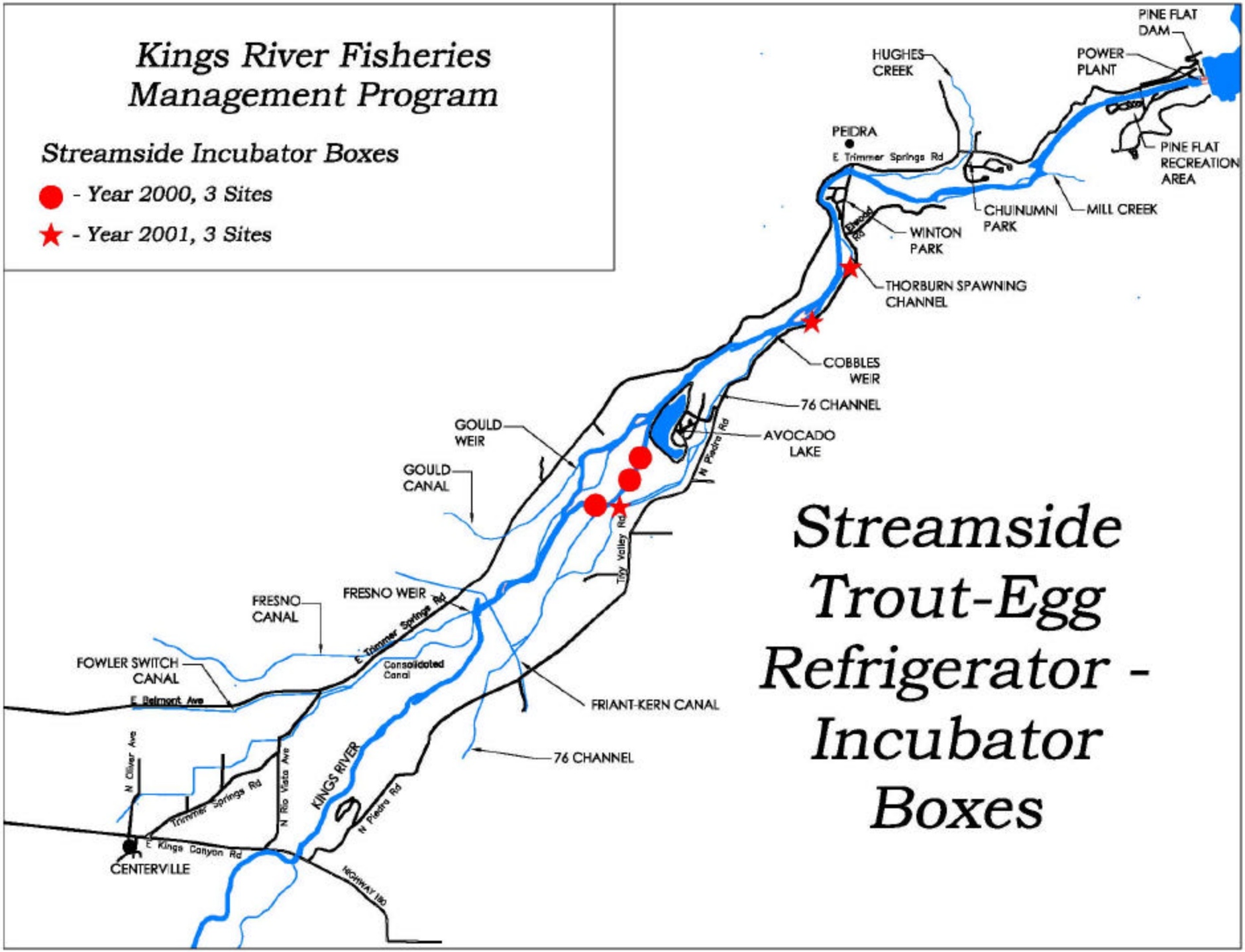


Figure 5-3 - Map showing Temporary Streamside Incubator locations.

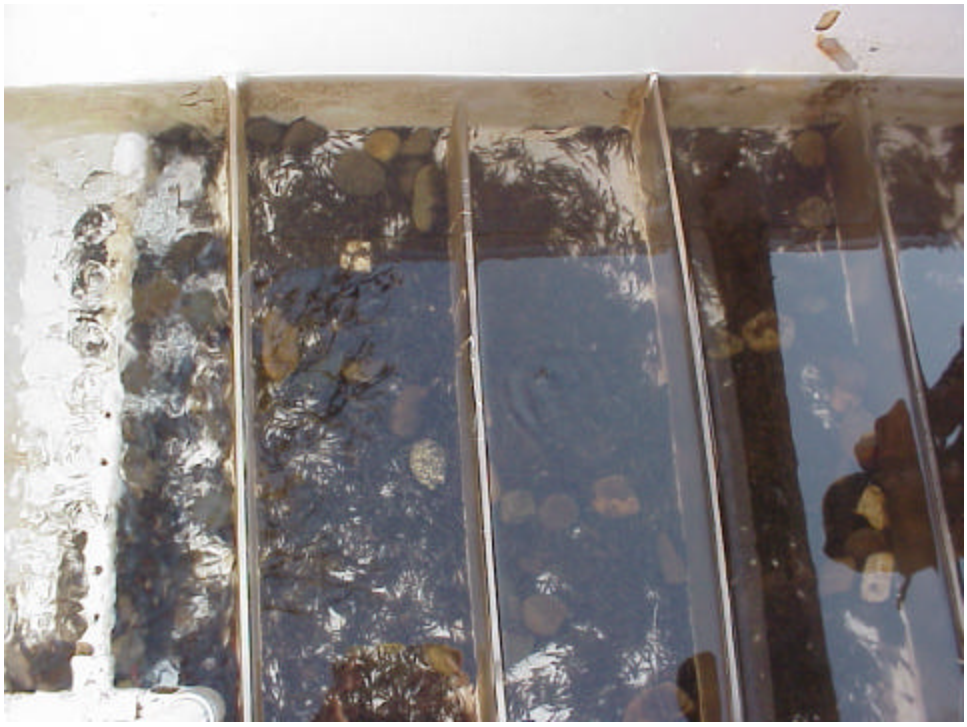


Figure 5-4 – Streamside incubator showing baffles and thousands of newly hatched trout fry.

Figure 5-5 – Members of the PAG digging artificial redds for placement of trout eggs in the river.

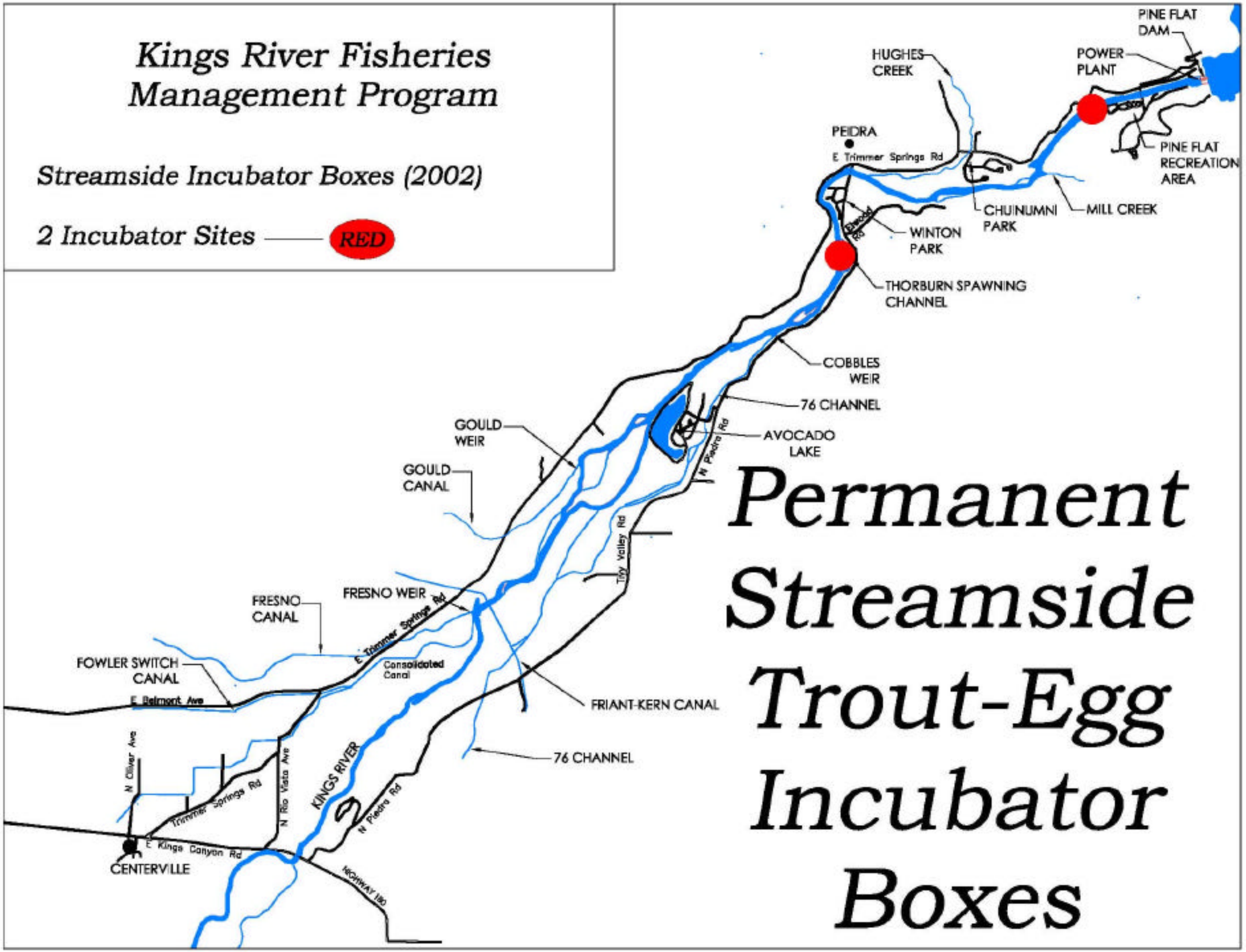


Figure 5-6 – Permanent Streamside Incubator locations.

The hatching of trout eggs in either the WVB's or streamside incubators has been a very effective tool of introducing fry into the lower Kings River that have gone through a somewhat "natural" hatching process. Hatching success has averaged between 80-90% in most instances. During this process the trout fry are subjected to many of the same physical requirements of the hatching process that would occur in the wild. It is assumed there is some natural selection that occurs and those fry that are less fit do not survive. However, subsequent sampling does not result in any indication that additional trout are present in the population. We have learned a great deal about what is required to introduce fry into the river from eggs and believe that this may eventually be a useful tool for compensating for the current lack of spawning sites at a very low cost. This will be a very effective tool if we can eventually replace trout eggs currently used from hatchery broodstock with eggs from wild trout from the lower Kings River.

The TSC would also like to use the streamside incubators in the spring and summer when rainbow trout eggs are available. This is during peak irrigation releases, and the streamside incubator boxes must be placed out of the stream channel. This eliminates the gravity flow of water from the river through the boxes and over the trout eggs. The TSC is investigating potential locations for the incubators and requirements for pumped water supplies and filtration systems to facilitate rainbow trout egg incubation and hatching during the spring and summer.

5.2.3 Trout Stocking

During 2002-2003, catchable sized rainbow trout were stocked in the lower Kings River by CDFG on a regular basis at selected sites. Based on professional judgment and trout tagging studies from other waters, trout stocking was changed to once per week during the irrigation season (roughly end of March through late September) and twice per week during the non-irrigation season. The stocking schedule is based on the assumption that the return of trout to the angler is higher during the low flow period.

5.2.3.1 Subadult Trout

About 36,000 subadult trout (4-6 inches in length) were stocked in the lower Kings River on December 10, 2002. These fish were provided by the CDFG at no cost to the FMP. All of the subadult trout were marked by removing the adipose fin. Subsequently, only a small number of the trout released at the subadult stage have been recaptured in the electrofishing surveys or reported as part of the recreational angler harvest. Although a small number of these fish were seen in subsequent electrofishing surveys, the fate of the majority of subadult trout released into the river is unknown. While additional sampling needs to occur to determine the survival of these fish, the stocking of subadults has not been a successful method of adding trout to the Kings River population in the past. Factors affecting the survival and distribution of subadult trout within the lower river are largely unknown, however, the available data suggest that subadult trout stocked in the river are not surviving through the winter and do not represent a significant contribution to the adult population. The fish seem to migrate downstream within days of being stocked in the river. It is hoped that as the habitat, including minimum flows, is improved, both egg incubation and stocking subadult trout that rear in the lower river will become important tools for supplementing natural trout reproduction in the river.

As habitat conditions within the lower river improve, through habitat enhancement projects such as those constructed during 2002-2003, the survival and contribution of subadult trout to the adult population is hoped to increase.

5.2.3.2 Catchable-sized Trout

The CDFG stocked a total of 35,300 pounds (70,600 trout) of catchable size trout in the Kings River below Pine Flat Dam between May 28, 2002 and April 14, 2003. Since stocking continued throughout the remainder of 2003, and because CDFG normally calculates fish stocking from January 1 through December 31 of a given year, these figures will change. CDFG hatchery staff is currently planting large numbers of catchable trout and plan to meet or exceed the 38,000 pounds of catchable trout that CDFG allotted to the Kings River.

5.2.4 Supplemental Trout Stocking

Trout downstream of Pine Flat Dam are maintained by coldwater releases from the dam. In the absence of Pine Flat Dam, the lower Kings River would have been a seasonal coldwater fishery. Given the natural hydrological cycle and the lack of a temperature control structure on Pine Flat Dam, during drought years, the coldwater trout fishery downstream of the dam will be subjected to warm water temperatures. It is best to be prepared for this event and have a plan to revitalize this coldwater fishery as soon as practical. Supplemental trout stocking using catchable, subcatchable and fingerling trout, and trout egg planting would be conducted following a year when the fishery is damaged due to the warmwater conditions. The funding necessary to replenish the fishery through a stocking program would be expended by the FMP over a two to three year time period. This would preclude the circumstance of intensively stocking the river just for another warmwater event should a drought continue.

The TSC investigated and developed a comprehensive plan that addressed the issue of revitalizing the coldwater fishery after critical hydrologic cycles. Recognizing that it will take a series of related actions, the TSC investigation included:

- Timing of CDFG catchable trout stocking;
- Acquiring bonus trout (broodstock);
- Options contract for supplemental trout stocking;
- Trout egg planting;
- Fingerling trout stocking; and
- Reintroduction of Wild Trout.

The TSC, after much work and negotiations, developed a unified plan, which focused on supplemental trout stocking (Appendix E). Temperature event trout stocking is currently not anticipated to be required because the new turbine bypass and releases from the bottom gates of

the dam will prevent or lessen warm water temperature events in the future. The decision was made, based on concerns expressed by the PAG in spring 2003, that no additional trout would be purchased using Framework funds at this time. The supplemental trout stocking plan is available and functional should stocking become desirable.

5.2.5 Collecting and Planting Eggs from Wild Trout

Section G (1)(j) of the Framework Agreement addresses stocking issues. Element #N-2001-3 of the 5-Year Plan describes the TSC's intent to establish a comprehensive supplemental stocking program. While this program has yet to be finalized, the TSC agrees that it will include a wild trout component. Currently only hatchery trout eggs are planted in the Kings River. These hatchery eggs come from stocks that have been raised for specific attributes such as rapid growth and ease of handling in the hatchery system. These may not be characteristics that make them as well suited as wild trout for survival in the lower Kings River.

The TSC has begun planning for this element's task of collecting eggs from wild trout for planting in the lower Kings River. Eggs will be taken from wild rainbow trout from the Kings River watershed. There are two proposed methods for acquiring wild trout eggs for this program. The first method would be to collect fall spawning rainbow trout from the riffles downstream of Pine Flat Dam. The second method would be to collect spring spawning rainbow trout upstream of Pine Flat Reservoir. Either method will require the trout to be collected, held, sorted based on readiness to spawn, stripping of the eggs and milt from the trout, and fertilized. The fertilized eggs would either be placed in the streambed using Whitlock Vibert boxes, or the boxes could be placed in the streamside incubators.

Collecting and spawning trout in the wild is difficult. Often the males and females are not always ripe at the time of capture and have to be held. During 2002-2003, a 14-foot diameter tank was purchased by CDFG and set-up at San Joaquin Hatchery. The hope is to capture trout from the lower river (preferably rainbow trout that spawn in the fall) and hold them at the hatchery until they are ripe and can be spawned. A similar program has been successful at the CDFG's Kern River Planting Base. The trout will have to be checked and cleared for diseases by the CDFG pathologist before they will be allowed into hatchery facilities. The collection of trout for transport and holding prior to spawning within the hatchery is pending review and approval by CDFG.

5.3 RESERVOIR

5.3.1 Kokanee Salmon

Kokanee salmon (*O. nerka*) were stocked in Pine Flat Reservoir on May 3, 2002 when 99,995 were planted (595 pounds) from the Taylor Creek Strain. CDFG has allotted 100,000 kokanee for planting in the reservoir during 2003. These were stocked on May 8th and 27th 2003 and numbered 100,067 fish totaling 727 pounds.

5.3.2 Catchable-Sized Trout

A total of 25,000 pounds (55,360 fish) of catchable-sized rainbow trout were stocked into Pine Flat Reservoir in 2002. In 2003 24,000 pounds or 47,500 trout were stocked as of December 10, 2003 with one plant still remaining of approximately 5,000 pounds or 10,000 catchable sized trout.

5.3.3 Chinook Salmon

Chinook salmon (*O. tshawytscha)* were last stocked in Pine Flat Reservoir in 1999 when 30,600 catchable sized fish from the Feather River Hatchery were stocked. Chinook salmon were not stocked during this reporting period due to fish diseases discovered during routine checks of the fish while in the hatchery.

5.3.4 Florida Strain Largemouth Bass

No Florida strain largemouth bass were planted in Pine Flat Reservoir during this reporting period by the FMP. Local bass angling clubs, funded by Fresno County Recreation and Wildlife Commission and other monies, have planted between 2,000- 5,000 Florida strain largemouth bass annually from 1991 to 2000. The bass have ranged in size when planted between 2 to 10 inches.

5.3.5 Florida Strain Bluegill

Two morphologically distinct subspecies of bluegill are native to the east coast of the United States: the northern bluegill (*Lepomis macrochirus macrochirus*) and the southeastern bluegill (*L. m. purpurescens*). The northern bluegill is common to the St. Lawrence and Mississippi drainages. The southeastern bluegill is native to Florida and southern Georgia and is rumored to grow larger, at a faster rate and be hardier than the northern bluegill (Hubbs and Allen 1944). The southeastern bluegill is believed to spawn earlier and in deeper water than the northern subspecies, although this is not supported in the literature. If this is true, this subspecies may be more successful in spawning given the surface water fluctuation pattern at Pine Flat Reservoir.

The introduction of Florida strain bluegills into Pine Flat Reservoir was done at the encouragement of a local angling organization, including members of the Clovis Bass Club. Approximately 2,500 adult bluegill were electrofished from Lake Perris in southern California and transported to Pine Flat Reservoir by CDFG fishery biologist Mike Giusti and planted June 21, 2002 after passing an examination by CDFG pathologists. The fish ranged in length from 4 to 6 inches. Floy tags (green tag shown in Figure 5-7) numbered 0001 to 0054 were attached to 54 bluegills. If the fish are captured, anglers are asked to call the CDFG in Fresno with information about when and where the fish was caught, as well as size and condition of the fish. There is no monetary reward for these tags. To date, no tags have been returned to the CDFG. This is a very small number of tags and not much can be concluded from this lack of tag returns.

Figure 5-7 – Tagging procedure applied before introducing Florida strain bluegill into Pine Flat Reservoir.

At the request of local anglers, Fresno County Recreation and Wildlife Commission provided $7,500 to purchase 3,700 3-4 inch long Florida strain bluegills from a local aquaculturists for stocking in Pine Flat Reservoir. These fish were stocked in the reservoir in March 2003. The original agreement for bluegill stocking stipulated that stocking would occur once. Unless there is a loss of the initial year-class, the initial stocking is expected to establish a self-sustaining population within the reservoir assuming these fish have a selective advantage over their northern relatives. However, anglers have requested that annual stocking of bluegill be included in the fishery program 5-Year Plan. It is anticipated that angler organizations will ask the county commission for additional funding. Since CDFG Region 4 will no longer have a reservoir biologist position effective July 1, 2003, CDFG's participation in any future stocking activities is uncertain.

Electrofishing was conducted on numerous occasions to monitor the fish populations at Pine Flat Reservoir and specifically to look for both tagged and untagged specimens of Florida strain bluegill (Section 6). The more than 500 bluegill captured made up over 29% of all fish captured by electrofishing but did not contain any fish that could be identified as being Florida strain bluegill. Of all the bluegill contained in angler's creels, which were observed, measured and identified, none were tagged or resembled Florida strain bluegill. The TSC recommends that the introduction of additional Florida strain bluegill will probably not make a difference in the final genetic make-up within the reservoir. We should determine the positive and negative effects of the introduction prior to continuing this program in future years.

5.4 Summary and Discussion

Members of the TSC are pleased with the current rainbow trout stocking effort in the lower Kings River and anticipate no changes to the numbers or location at this time. The survival of young fish appears to be low. Adult trout produced from introduced eggs or subcatchable stocking appear to represent less than 1% of the adult population. We are not sure if this due to the strains of trout being used to produce the eggs incubated in the river as part of this program or, more likely, the absence of suitable habitat for juvenile, subadult, and adult trout within the lower river. We believe that we have worked out most of the "bugs" in the trout planting process for both young fish and eggs. As escape cover for young trout is improved, we hope that this results in improved survival. The TSC plans to continue to experiment with different strains of trout, including wild trout, in an effort to increase the size and numbers of the trout population.

As part of the FMP the TSC is continuing to evaluate the current and potentially alternative stocking strategies for species such as bluegill within Pine Flat Reservoir and trout within the lower river. Tests are being conducted and monitoring performed as part of the fishery program to further evaluate the survival and contribution of fish stocked at various life stages to the adult population. Based upon the available results from the fishery monitoring it currently appears that trout fry and subadult trout do not contribute significantly to the adult trout population within the lower Kings River. Furthermore, results of the tagging program demonstrate that harvest rates on catchable trout are relatively high and that the abundance of catchable trout declines substantially within a relatively short period of time (weeks) after stocking within the lower river. Based upon the available information the TSC has recommended a strategy to stock trout within the lower river, with the experimental augmentation of the egg incubators, under current conditions. As habitat conditions improve within the lower river, through implementation of habitat enhancement projects such as those conducted during 2002-2003, it is expected that in-river spawning and juvenile rearing will contribute more significantly to recruitment to the adult population. As habitat improves, the TSC currently anticipates a change in stocking strategies with a reduction in stocking catchable size trout and an increased emphasis on stocking, and providing more favorable rearing conditions, for early life stages of trout.

Members of the TSC believe the monitoring results demonstrate that the fishery and current management at Pine Flat Reservoir is satisfactory and no changes should be made in current stocking practices. Habitat improvement work needs to continue on an annual basis. However, with the loss the CDFG Region 4 Reservoir Biologists position, it is unclear who will do this work. ACOE personnel have done some habitat work in the past. Anglers have also accomplished some work, but it is unclear who will coordinate and implement these activities.

6.0 MONITORING

6.1 INTRODUCTION

Section 1(k) of the Framework Agreement "Development of Criteria/Monitoring" calls for the agencies to carry out a monitoring program to determine the effects of various elements of the FMP and the overall status of the fishery. One objective outlined in the 5-Year Plan is to establish a comprehensive monitoring program that will in turn provide the agencies and the public with a gauge with which to evaluate the status of the fishery and the relative merits of any particular project.

The monitoring activities recommended by the TSC for 2002-2003 included efforts to address specific evaluation objectives within a relatively short time period (1-2 years)(special studies) such as the study to characterize the lower Kings River macroinvertebrates. Results of these special studies would subsequently be used to further evaluate and refine, if needed, future investigations. Other monitoring activities, such as real-time temperature monitoring and adaptive management decisions would be triggered by specific environmental conditions and events, and would not be required each year. Monitoring the status and trends of the lower Kings River trout population and assessing the performance of the overall program in improving habitat quality and availability and increasing trout reproduction, growth, survival, and abundance within the lower Kings River is being performed consistently over a long period of time (baseline) to assess trends in population abundance. Results of monitoring activities within the lower river and Pine Flat Reservoir are briefly summarized below.

6.2 RIVER

6.2.1. Annual Fish Population Surveys

Long-term annual baseline trout fisheries monitoring within the lower Kings River is being conducted as part of the FMP to determine (1) juvenile trout abundance and distribution; (2) adult trout abundance and distribution – fall and spring; (3) reproductive success, growth, and survival; (4) overwintering survival, size and age structure of the population; and (5) assess the abundance and condition of the fish community inhabiting the lower Kings River.

The 5-Year Plan proposed that electrofishing surveys will be conducted two times per year during (1) spring (prior to initiation of the major irrigation releases) and (2) fall (at the completion of the irrigation season). Electrofishing is performed at sampling sites within each of the three management reaches of the lower Kings River (Figure 6-1). Surveys are conducted at the same sampling sites each year for use in establishing an abundance index, and for determining interannual trends in abundance of trout and other fish species. Sampling is conducted using block nets and mark-recapture methods to allow for the calculation of confidence intervals for estimates of abundance. Results of electrofishing surveys include species composition, length frequency analysis, condition factor (length-weight relationship), and estimates of abundance. Electrofishing surveys have been conducted over a number of years (since 1983) in the Kings River by KRCD and CDFG, which have been used as the foundation for expanding the monitoring program. To the extent possible, sampling methods and the

Figure 6-1 – Electrofishing survey to determine trends in fish populations.

sampling location utilized in previous surveys by KRCD have been incorporated as part of the electrofishing monitoring program to allow comparison of current results with previous monitoring.

The annual electroshocking survey of the lower Kings River fisheries is conducted by KRCD with the assistance of CDFG, KRWA, and anglers (Figure 6-1). Seven sites, ranging from 200 to 500 yards in length, were sampled using backpack electroshockers in December 2002 (Figure 6-2). Crews consisting of 15 to 24 people and from five to seven electroshockers were used to conduct the sampling. Low numbers of small rainbow trout were caught at five sites upstream of Fresno Weir and no trout were caught at one of the two sites sampled downstream of the Fresno Weir. Trout were present at the second sampling site located downstream of Fresno Weir. The numbers of wild trout captured in 2002 were similar to that of recent, non-drought years. No large 1+ year old trout were captured at any of the seven sampling sites. As in past years, the most abundant fish were the Sacramento sucker (*Catostomus occidentalis*) and riffle sculpin (*Cottus gulosus*). Figure 6-3 shows a composite of 20 years of wild trout catch-trends from the annual electrofishing surveys for the lower Kings River.

The 2003 annual event was postponed until February 2004 due to high river flows.

6.2.2 Coves and Jetties Monitoring

Juvenile trout habitat enhancement projects (i.e. coves and jetties, boulders, and channel ripping) constructed on the lower Kings River were monitored in the summer and fall of 2002 and 2003 to determine if they are physically stable, function properly, and are used by fish, including species, size and relative abundance. Results of visual observations of physical habitat projects following exposure to high irrigation flows are presented in Section 4.

We know very little about the spawning activities of trout in the lower Kings River. Large trout (5-6 pound) have been observed spawning immediately downstream from Pine Flat Dam during the winter (December-January period). It is anticipated that the young-of-the-year (y-o-y) trout resulting from winter spawning would hatch and be in the lower velocity backwater areas beginning in March. Other strains of rainbow trout are expected to spawn during the typical late winter-spring season (e.g., February to June; Moyle 2002). Young-of-the-year trout resulting from spring spawning would be expected to be using the slow velocity habitat between mid-April through mid-August. Young-of-the-year brown trout have also been observed inhabiting the lower velocity areas within the river during the late spring and summer. It is important to determine when the y-o-y trout occupy various habitats within the lower river, as well as some

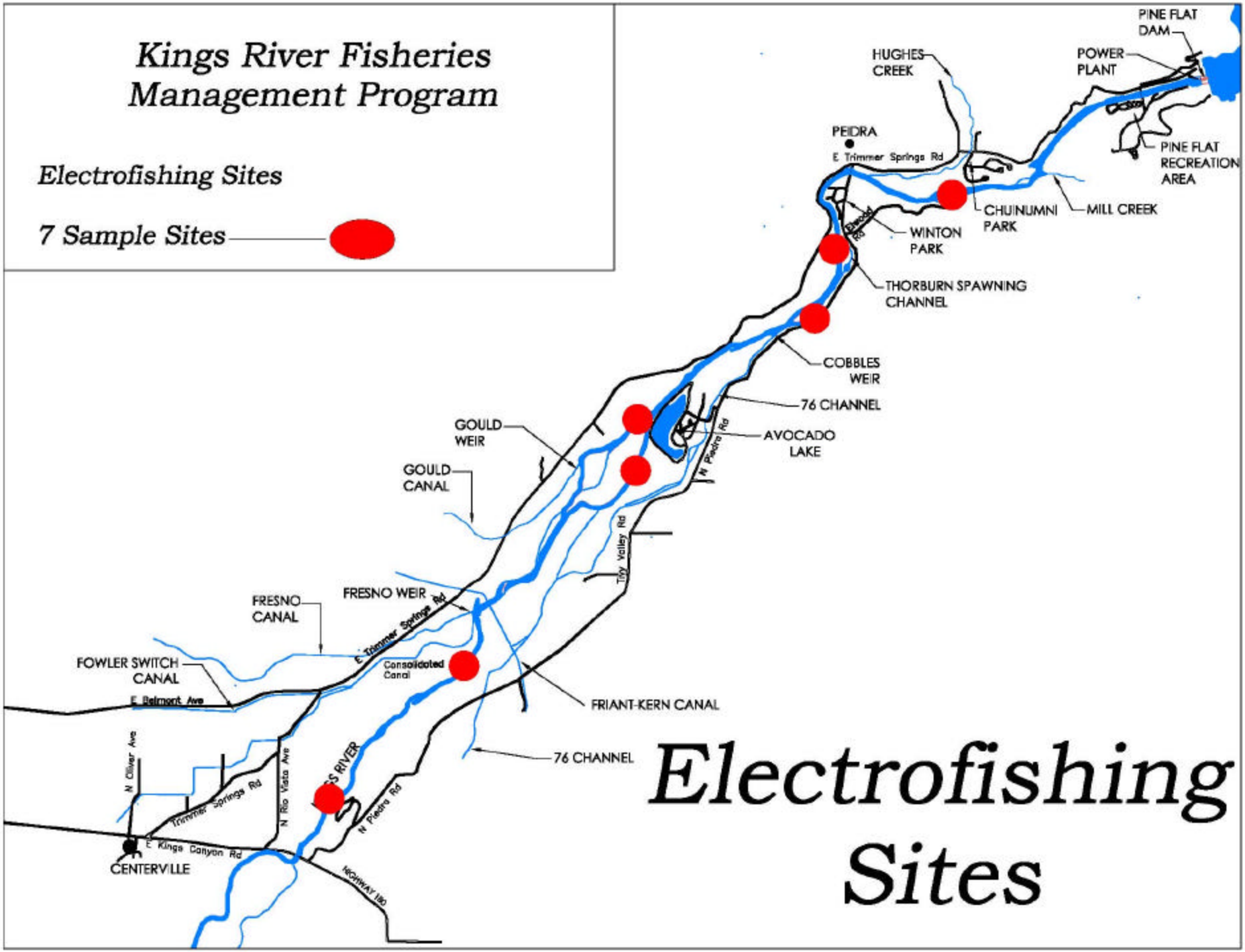


Figure 6-2 – Map showing electrofishing stations.

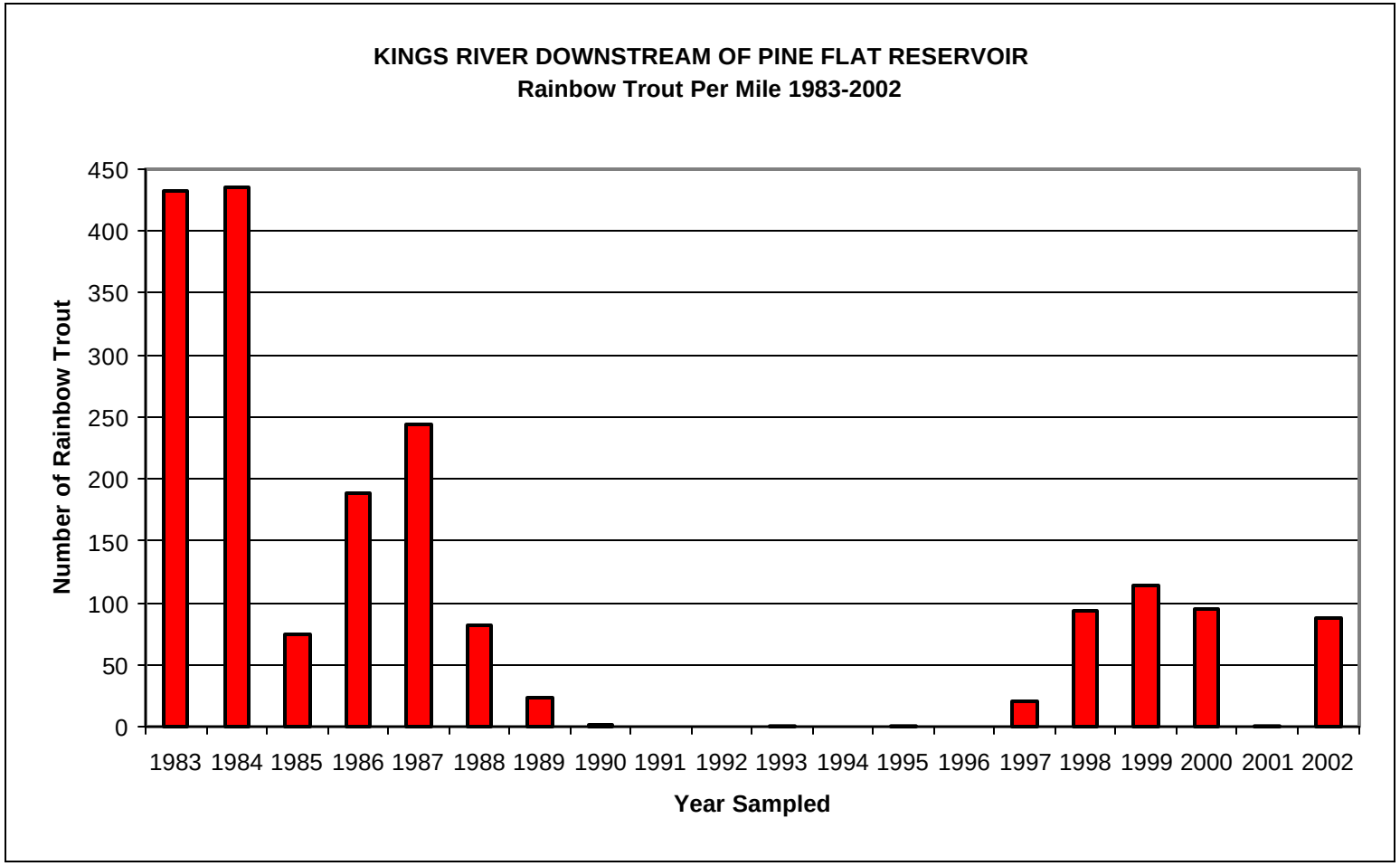


Figure 6-3 – Trend in number of wild trout captured during annual fish surveys over the last twenty years.

basic information on size, growth and condition. Some smaller fish, like threespine stickleback, also find low velocity backwater habitat advantageous at all times it is available.

As part of the FMP special studies an effort should be made to sample the coves and jetties bi-monthly during the irrigation season. It may require at least one season for the structures to become "seasoned" and desirable as habitat. Information on the physical characteristics of areas associated with the coves and jetties, in addition to information on fish use, will provide valuable insight into the evaluation of the performance of these structures in improving habitat for juvenile fish, particularly during the higher flow irrigation season. The basic monitoring plan for evaluating the coves and jetties is outline below.

Pre-project sampling

In an effort to determine if coves and jetties provide a low velocity area desirable to small fish, especially trout, the three coves and jetties sites were sampled on July 18, 2002 prior to construction using backpack electrofishers (Table 6-1). Due to the high flows (5,000 cfs), the river could only be sampled 2-3 feet from the river bank. Within the general construction area, three 25-yard reaches of shoreline were selected for sampling and marked with rebar as locators (GPS locations for each site have been recorded). Three similar sections of shoreline near the construction sites have been identified to act as control areas. Control sites consist of similar shoreline habitat as the construction sites. Pre-project sampling at the six sites was limited to one season. Three project sites and three controls (no construction) were sampled to determine the abundance and species composition of fish present at each site. Monitoring at the coves and jetties and control sites is scheduled to occur for three years or until the effectiveness of the structures is documented.

Sampling consisted of collecting information on the use of the area by fishes and measurements of basic physical parameters (e.g., water depth, water velocity, etc.). Near-shore sampling was conducted using backpack electrofishing units. Coves and jetties were sampled using one or more backpack electrofishing units. Using standard electrofishing techniques, sampling started at the end of the jetty away from the bank and moved towards the shore. Fish stunned by the electrical current were netted and held for later analysis. Once this sampling was completed at the jetty, the workers move into the cove area and sampled using the electrofisher. All netted fish were held in a separate container for later analysis.

Post-project sampling

On August 11, 2003, three sites were electrofished to determine species and size of fish present (Table 6-1). Site 1 was the coves and jetties construction site downstream of the Pine Flat Recreation Area, while the other two sites were controls.

Biological data

Once electrofishing was completed, all fish collected were identified to species, enumerated, lengths and weights measured, the condition of the fish recorded including any tags or marks, and the fish are returned alive to the river. Each sample was recorded and identified as an individual sample. Scale samples were collected for aging from a sub-sample of the various sized (age classes) trout.

Physical Features

Localized changes in stream velocity as a result of the construction of coves and jetties have been measured and documented over a range of river flows to assess the availability and suitability of habitat created by the coves and jetties for juvenile fish. Using a standard water velocity meter (Gurley meter, Marsh-McBurney or Pigmy meter), water velocity is measured from the waters edge out perpendicular to the shoreline at one-foot intervals a minimum of six feet (or less if flow conditions make wading unsafe). Velocity is measured at 6-inch intervals from the above the stream bottom to the water surface. Velocity measurements are made downstream of the jetties and include the coves.

Substrate is evaluated along the same transect as the velocity measurements. Visual estimates of percent composition of bottom materials are made. Bottom substrates are divided into fines, gravel, coble, boulder, and bedrock. Substrate classes are recorded as percentages (dominant, subdominant substrate types). This technique is quick and provides adequate resolution for detecting gross changes in substrate conditions within the areas affected by the coves and jetties.

Photo point documentation is recorded at each sampling site during each survey using color slides or digital format. Each photo is identified as to sample site, including control sites. Steel rebar has been driven into the ground and used as a reference, along with a compass, for duplicating photos from one survey to the next. The photos from the previous survey are taken into the field so that landmarks can be identified and duplicate photos made using these reference sites, the rebar reference mark and the compass to duplicate bearings during each survey.

In addition to the photo points, a total station has been used to document the original location of selected jetties. These surveys will be repeated at the end of the irrigation season for a period of up to three years, or as needed, and determinations made if there is any significant movement of these structures. It is possible that under flood flows, the jetties could be destroyed or altered in their size and/or shape.

Preliminary results and observations indicate that coves and jetties constructed of large cobble and small boulders are velocity stable and maintain their shape during the high irrigation flows. Coves and jetties composed of sand and smaller cobble did not maintain their shape under high irrigation flows and were rendered nonfunctional.

Results of Cove and Jetty Fishery Sampling

The coves and jetties were functional in providing calm, shallow water shoreline habitat for rainbow trout fry and fingerlings. In April 2003, KRCD biologists observed a few to numerous 1-2 inch rainbow trout swimming within each cove at the Pine Flat Recreation Area. No young trout were observed at the same time at the cove and jetties site ¼ mile downstream from the above site. Thus, trout fry and fingerlings use varies drastically between sites and is dependent upon the distance to spawning locales, specific site characteristics, and likely various other unknown factors.

Season / Site	Location	Total Sampling Time (Seconds)	Fish Collected
Pre-project (7/18/02)			
Site 1-Test Site	Pine Flat Recreation Area	2214	7 S. sucker 3 sculpin 1 S. pikeminnow 1 rainbow trout
Site 2-Control Site	Pine Flat Recreation Area	1438	3 S. sucker 2 sculpin 1 rainbow trout
Site 3-Control Site	Downstream of Alta Weir	2224	4 S. sucker 3 sculpin 2 S. pikeminnow 1 lamprey
Post-Project (8/11/03)			
Site 1-Test Site	As Above	2,837	20 S. sucker 5 sculpin 7 S. pikeminnow
Site 2-Control Site	As Above	784	1 S. pikeminnow
Site 3-Control Site	As Above	993	4 S. sucker 1 sculpin 6 C. roach 2 hardhead

Table 6-1 – Summary of pre- and post-electrofishing survey of coves and jetties and control sites.

Results

Results of electrofishing surveys conducted at the cove and jetty sites and control areas before and after construction of the structures are presented in Table 6-1. Survey results showed that a variety of species, including Sacramento sucker, Sacramento pikeminnow, and rainbow trout were present at the sites before and after construction of the coves and jetties.

Pre and postproject electroshocking produced a low abundance and similar species assemblages of fishes. From the information collected on the two sampling dates, no definitive conclusions can be made about the value of the coves and jetties. The TSC feels that the electroshocking sampling is biased and does not accurately show the benefits of the project (see comments below).

In future monitoring, it is recommended that electroshocking sampling be conducted in the April-May time period when trout fry are known to be available and inhabit the coves and jetties. As noted earlier in the Physical Features section, many trout fry were visually observed using the coves in April 2003 at one site. At another cove and jetty site located ¼ mile downstream, no trout fry were observed. Thus, when the post-project sampling was conducted in July or August, the trout fry may have already used the coves and jetties, grown in size, and moved out of the coves to occupy other habitat types. In summary, the TSC feels that the electroshocking sampling results are biased and the benefits and value of the coves and jetties are not accurately represented by the survey data collected in 2003. The monitoring program for coves and jetties will be modified in future years to sample at the appropriate time of year for trout fry.

Fish population estimates in deep water areas

A whitewater electrofishing raft has been developed for use in the fishery-monitoring program to sample deeper water higher velocity areas that cannot be effectively sampled using the backpack units. A study plan was developed that called for a mark and recapture rainbow trout population estimate for selected stream reaches. Under this plan, the raft makes a pass down the left, center and right bank collecting, marking and releasing trout on each pass. Due to the high flows and safety concerns, there are only certain flows (about 300 cfs or less) that this sampling can occur. No block seines are used, again due to high flows. After a few days rest, the same area is electrofished and all fish captured are inspected to detect the presence of tags. Based on the ratio of marked to unmarked fish, a population estimate, with confidence interval can be calculated.

An initial trial of the effectiveness of the electroshocking raft was conducted in June 2002 in the Avocado side channel. While the electrofishers worked well, finding a large population of Sacramento suckers but no trout, several leaking valves made the raft unsafe to use. By the time the replacement parts arrived, the flows were too low for additional sampling to occur. We believe this is potentially a valuable sampling tool, allowing sampling to occur on the Kings River in the deeper pools that have not been sampled using the backpack shocking units. The electrofishing raft will be tested again in 2004 to evaluate its merit as a fish sampling-monitoring technique.

6.2.3 Boulder Clusters and Channel Ripping

Boulder clusters have been added to various reaches of the lower river as part of the 2002-2003 habitat enhancement projects (Section 4.1.3) to provide addition habitat and escape cover from high irrigation flows. Fishery sampling of boulder clusters was planned to occur at the same time coves and jetties were sampled.

Pre-project sampling was conducted at a proposed boulder site on July 18, 2002. However, that boulder project was moved to another site and not implemented at the pre-project sampling area. Thus, no post-project sampling of the 2002 boulder project occurred. The sampling at the proposed boulder site (pre-project and post-project) was therefore used as a control site for monitoring of the coves and jetties projects.

Shoreline boulder clusters have been electrofished using backpack electrofishing units in the past. Stunned fish are captured and pertinent information recorded along with the number of seconds the unit was on. Sampling using the electrofishing raft will also be performed to determine fish use in deeper water areas associated with the boulder clusters.

Results of physical observations and electrofishing surveys have demonstrated the use of the boulder clusters as habitat by both juvenile and adult trout. Based on results of the fishery monitoring conducted at the boulder sites, the TSC has recommended that additional boulders be placed into the river to further enhance habitat quality and availability for trout both during the irrigation and non-irrigation seasons.

Channel ripping was performed as part of the 2002-2003 FMP (Section 4.1.5) to improve substrate characteristics and reduce sediment armoring. Results of visual observations and a qualitative assessment of substrate conditions indicated that the ripping was effective in opening gravel and cobble deposits and providing improved substrate conditions (e.g., reduced armoring, reduced fines, increased interstitial spaces, improved cover and use by fish, etc.).

6.2.4. Thorburn Spawning Channel

Monitoring is routinely performed to evaluate biological and structural characteristics of the Thorburn Channel. The monitoring has been designed to determine what species of fish are using the channel and when they are present. The Thorburn Channel was surveyed using electrofishing techniques during the year. In addition, visual monitoring is performed to assess the integrity, stability, and suitability of the channel and structures.

Monitoring of the Thorburn Spawning Gravel Project was included as Element #C2 in the fishery programs first 5-Year Plan (May 2000). A study plan was developed by the TSC titled "STUDY PLAN: Monitoring of the Thorburn Spawning Gravel Project (Element #C2)." The study plan (Appendix F) was presented and released to the public at the Executive Committee Meeting in December 2000. No comments were received on the study plan. During 2001, tasks of the plan were conducted and a Summary Report was included as Appendix 2 to the second 5-Year Plan (June 2001). A more detailed monitoring plan was subsequently developed (Appendix F) and may be implemented in the future.

Results

Three 50-meter reaches of the channel were electroshocked to determine what species of fish inhabit the channel. The three reaches were selected to comparatively sample a reach with no woody debris cover, a reach with moderate woody debris cover, and a reach with a large quantity or abundance of woody debris cover. The woody debris cover is composed of 2 to 3 large tree trunks which were placed and anchored together in the channel to provide fish hiding cover. The cover is located along the length of the channel with some having been placed in the center and some along the banks of the channel.

Electroshocking showed that nine species of fish inhabit the channel (Table 6-2). The greatest abundance of fish occurred in the reaches with moderate and abundant fish hiding cover. Few fish were observed in the reach with no hiding cover. Only a few rainbow trout (total of 10) were caught in the sampling and most occurred in the reach with abundant hiding cover (Table 6-2). All of the trout caught were juvenile trout that ranged from 3 to 6 inches in length. Half of these trout were wild or native and half had been planted by the FMP. These trout are thought to have moved into the channel as no trout were planted in the channel and trout spawning has not been observed in the channel during cursory visual surveys. Sacramento sucker, California roach, and sculpin were the three most numerous species observed. A large number of lamprey (probably Kern brook lamprey - a species of special concern to the CDFG), relative to other river sampling sites, were found in the channel. Prior to and during the sampling, the channel's flow was minimal and confined mostly to the low-flow half of the channel. Thus, at the time of the December sampling, trout and other fish abundance are thought to be at minimum levels. Fish abundance is thought to be higher in the spring and summer periods when the channel's flow is greater and the channel is watered bank to bank. Also, during the spring and summer time period, fish are thought to move into the channel to avoid the high and turbulent flows in the main channel of the Kings River. Thus, the sampling in December may not accurately reflect the overall fish abundance and use of the channel during the rest of the year; however, it does show that various fishes (including rainbow trout) have occupied and inhabit the channel.

Visual monitoring of the channel and cover structures showed that the banks are stable and the integrity of the channel is functional. A few areas of the low-flow channel have become filled with cobble and sand from minor bank slumping. In these areas, the low-flow subchannel is approximately the same elevation as the high-flow subchannel. This does not poise a significant problem to flows or to fish habitat in the channel. Also, several of the anchored tree trunks providing fish hiding cover have broken free and washed down the river. Each fall and winter in the low-flow period, Beavers continue to cut willow trees in the area and build a dam upon the water elevation control, k-rail structure. The beaver dam raises the water level in the rearing pond and in the channel upstream of the pond. The beaver dam has a negative effect by turning the flowing channel into a stagnant slow-flowing backwater. The k-rail is checked every two weeks and if present, the beaver dam is removed. The Fresno County trapper removes beavers from the channel several times each year. This is an on-going maintenance problem with new Beavers moving into the channel during winter.

Common Name	No Cover	Moderate Cover	Abundant Cover
rainbow trout – native	-	2	3
planted - catchable	-	-	-
planted - juvenile	-	-	5
brown trout	-	-	-
white catfish	-	-	-
smallmouth bass	-	-	-
largemouth bass	-	-	-
spotted bass	-	-	-
Sacramento sucker	6	83	219
Sacramento squawfish	-	8	18
California roach	-	46	119
sculpin ssp.	10	22	118
lamprey sp.	79	3	81
stickleback	20	42	26
green sunfish	-	-	10
bluegill	-	-	-
mosquitofish	-	-	4
brown bullhead	-	-	-
hardhead	-	-	-
carp	-	-	-
golden shiner	-	-	-

Table 6-2. Fish observed in the Thorburn Spawning and Rearing Channel during Electrofishing December 2, 2002.*

* Three 50-meter reaches were sampled which have different amounts of woody debris, fish hiding cover.

6.2.5 Spawning Gravel Placement Monitoring

As part of the habitat enhancement actions performed in 2002-2003 spawning gravel was placed in the lower river at three sites (Section 4.1.6) to improve habitat quality for trout and macroinvertebrates. Gravel monitoring has been included as part of the habitat enhancement action to assess performance of the action. The goal of monitoring the spawning gravel is to evaluate the physical changes at the gravel augmentation sites, gravel size distribution, and mobility of the gravel placed in pre-selected sites as described in Element #C-2001-3 Gravel Placement in the Kings River of the 5-Year Plan for program year 2001-2002.

Monitoring was completed for spawning gravel placed in 2002 on the Kings River. Two sites were selected from the four sites planned for gravel augmentation in the 5-yr Implementation Plan developed by the Technical Steering Committee on June 7, 2001. The goal for monitoring the import material was to evaluate the physical changes to the streambed, the import materials mobility, and to make recommendations in how to make the process more effective. Methods used to monitor the gravel include cross section surveys, pebble counts, bulk sampling, and tracer gravel placed on the augmentation sites. Monitoring data was then used to calculate and analyze sediment transport and bed mobility for the import and in-situ materials. The sites were monitored for baseline, as-built, and post-event data sets.

The baseline data provided a reference for comparison with the as-built and post-event data. Cross-sections were established and monumented with rebar pins prior to gravel placement. Pebble counts were then taken to determine the in-situ gradation of the streambed using Wolman's[1] method. From the pebble count data, a gradation curve is generated to represent the particle size distribution of the subject channel bed. Andrews[2] model for sediment transport is used to estimate the mobility of the particles and ultimately determine the flow necessary to move the particle. As-built monitoring consisted of surveying the augmentation sites at the monumented sections as well as analyzing bulk samples of the import material. A d_{84} and d_{50} was also developed for the import material so that an estimated transport flow could be developed for the gravel. Tracer gravel was placed at selected cross section to monitor mobility and test modeling assumptions.

Finally, post-event monitoring was performed once the irrigation releases ceased. Cross sectional surveys were performed as well as a visual inspection of the tracer gravel that was previously placed. There were no remnants of the import material left at the site. Releases were more than adequate to mobilize the ¼ " to 1 – inch gravel placed in the river. Recommendations to improve augmentation activities are as follows:

- Increase funding and scope for monitoring of these projects,
- Improve planning and execution of each project,
- Develop a hydraulic and sediment transport models for the reach,
- Revise import material specifications to include a wider range of sizes and increased d_{84} to increase its stability,
- Increase gravel augmentation quantity,
- Increase fisheries information collected to aid future planning efforts for the river,
- Consider alternative methods of gravel introduction.

6.2.6. Macroinvertebrate Survey

Members of the PAG raised concerns regarding the decline in macroinvertebrate abundance in the lower river in recent years. Many anglers can remember the days when in late evening the air was filled with large mayfly and caddisfly hatches. Monitoring of the macroinvertebrate population was first proposed under Activity B-6, monitoring, in the FY 2002-03 5-Year Plan.

Macroinvertebrates are an important element of the aquatic community inhabiting a river system. They serve as prey for juvenile and adult fish, are an essential element of the food web in converting of energy within an ecosystem, and serve as an indicator of habitat and environmental conditions occurring within the water body. In general, macroinvertebrate communities characterized by high diversity, balanced representation among taxonomic groups, relatively high abundance (density), and exhibiting a range of life history stages are general indicators of a high-quality habitat. In contrast, macroinvertebrate communities dominated by relatively few highly tolerant species having low diversity are typically viewed as indicators of a stressed or degraded aquatic habitat. The California Department of Fish and Game (CDFG 1999a) has developed standardized protocols for conducting macroinvertebrate surveys within a river system for use in evaluating and characterizing the habitat conditions (California Stream Bioassessment Procedure). To provide information on the macroinvertebrate community inhabiting the lower Kings River the California Department of Fish and Game, as part of the Kings River Fishery Management Program, collected a series of samples during the winter, 2003 for use as a preliminary indicator of the macroinvertebrate community inhabiting the lower river.

This study had two primary goals: 1) compare macroinvertebrate density (macroinvertebrates/area) and diversity (index of species present) between control (undisturbed) and project (where activity had occurred); 2) compare the results of this study to a similar study done in the early 1970s by Dr. Donald J. Burdick from California State University, Fresno. There were some difficulties with the way this 1970s study was designed which make the results less robust than the current study, however, this is the only historical macroinvertebrate information that could be located and for this reason is of some value for comparison to the current study. The methods and results of the macroinvertebrate survey are briefly summarized below.

Methods

Macroinvertebrate samples were collected from the lower Kings River using the standard rapid bioassessment protocol (California Stream Bioassessment Procedure; CDFG 1999a). Triplicate samples were collected at each of seven sampling sites, including one site which had recently received spawning gravel augmentation. The DFG State Water Pollution Control protocols (point source) were modified to include 3 transects from the control (undisturbed) and three transects from the project area (project area). The results are compared to determine if the project resulted in any significant change in the macroinvertebrate population. More important, this study provides an important baseline to which future studies can be compared.

Transects were selected by dividing the riffle into 30 equal longitudinal segments and using a random number table to select 3 transects to be sampled. Sampling was conducted at the above

series of transects established perpendicular to the flow of the river. Each transect contained 3 kick net samples, one taken from each side and the middle of the river. The kick net consists of a long wood handle attached to a D-frame net comprised of fine netting material (800 x 900μm mesh). The flat edge of the net is placed against the substrate and the net is allowed to extend downstream with the current. It measures one foot across the flat surface. The area sampled includes across the front edge of the net and upstream 2 feet (1' x 2') area for 2 minutes. Disturbance can include picking up and "washing" rocks by hand. The macroinvertebrates disturbed by this process are carried downstream by the current and into the net. The insects are "picked' from the net and stored in a bottle. Once the three samples have been collected from an individual transect, they are all combined and preserved in ethanol and labeled in one bottle. Due to the lack gradient, riffles with similar characteristics for use as controls were not always available immediately upstream. The water quality data was not collected since the study was examining physical habitat changes, and no differences in water quality were expected.

The sampling sites (Figure 6-4) surveyed as part of the macroinvertebrate investigation, with sampling conducted between the February 27 and March 3, 2003, are described below as the following reaches (KR) and summarized in Table 6-3 below:

KR-1: This site is adjacent to the Thorburn Spawning Channel (next to the KRCD angler survey box). This site serves as a control for the spawning channel and also as a downstream control for the Winton gravel/ripping project.

KR Reach 2: This site was just downstream of the mouth of the Thorburn Spawning Channel. This site serves as a control for the spawning channel and also as a downstream control for the Winton gravel/ripping project (no similar riffle upstream).

KR Reach 3a: This site was part of the gravel addition project located at the lower end of Winton Park. The gravel did not extend across the river, so the transect samples were placed in separate jars for analysis (KR-3b). Also, this area was downstream of the "ripped" section and had an increase in the fines and sand.

KR Reach 3b –New Gravel: Samples from transects which contained the new gravel.

KR Reach 4: This site was within the section that was deep ripped behind Avocado Lake.

KR Reach 5: This was the control site for Reach 4. Gradient was noticeably steeper than other sites.

KR Reach 6: This site was located within the Thorburn Spawning Channel. Control sites for the spawning channel are Reach 1 and 2.

Station	Number samples	Date Sampled	Description
KR-1	3	2/27/03	Control riffle adjacent to middle Thorburn channel
KR-2	3	2/27/03	Control riffle below inlet to the Thorburn channel
KR-3a	3	2/28/03	Lower end of Winton Park
KR-3b	3	2/28/03	Lower end of Winton Park – gravel augmentation
KR-4	3	2/28/03	Ripping site behind Avocado Lake
KR-5	3	2/28/03	Control site behind Avocado Lake
KR-6	3	3/3/03	Thorburn spawning channel riffle

Table 6-3 - Summary of 2003 macroinvertebrate sampling sites.

A total of 21 macroinvertebrate samples were collected. The macroinvertebrate samples were processed by ECORP Consulting with taxonomic identification of organisms to the levels specified by the CAMLnet Standard Taxonomic Effort (27 January 2003 revision). Individual sample processing was initiated by evenly distributing the entire sample into a pan marked with two-inch grids. Randomly selected grid portions (1/4, 1/2, or full grids) selected for sorting were placed in 100x15-mm Petri dishes. Samples were sorted using a dissecting microscope, and specimens were removed from the dish, identified, counted, and placed into a labeled sample vial. A minimum of 300 organisms was removed from each sample for identification.

The only other study of the macroinvertebrate population on the lower Kings River that we are aware of was conducted by Dr. D. J. Burdick, a professor at California State University, Fresno, during 1973 and 1974. The study was similar to the 2003 study, but the report was done under different circumstance, with some stations being sampled only days after being flooded. However, this is the only historical data available and we have attempted to compare the results to the current study to determine if we can detect any significant changes in species present, density or diversity.

Results

2003 FMP Study

The indices and general response to habitat impairment or degradation is summarized in Table 6-2. This table provides a brief explanation of what each of the metrics indicates about impairment to the habitat. Results of the sampling are summarized in Table 6-3, documenting results for

each individual sample in addition to the calculation of various indices for each sampling location. The indices are typically used to assess the overall characteristics and conditions of the macroinvertebrate community inhabiting a river using either (1) generic criteria developed from a variety of macroinvertebrate studies conducted over a wide range of environmental conditions or (2) by comparison to a reference/control site located within the river system of interest. As a result of the variability among watersheds, comparison with a site-specific reference/control station is preferable if the data are available. We attempted to evaluate controls (undisturbed) sites in this study; however, both the project and control sites are impacted equally by negative physical factors discussed below. The EPT Richness index referred to below (Table 6-5) is based on the presence of species from the Ephemeroptera, Plecoptera and Trichoptera families. These species are associated with good physical conditions.

BMI Metric	Description	Response to Impairment
Richness Measures		
Taxa Richness	Average number of individual taxa at each site	decrease
EPT Taxa	Average number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Cumulative Taxa	Total number of taxa at each site	decrease
Cumulative EPT Taxa	Total number of EPT taxa at each site	decrease
Dipteran Taxa	Number of taxa in the insect order (Diptera," true flies")	increase
Non-Insect Taxa	Number of non-insect taxa	increase
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with tolerance values between 0 and 3	decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Weighted average value (0-10) of individuals designated as pollution tolerant (high values) or intolerant (low values)	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Percent Chironomidae	Percent composition of the tolerant dipteran family Chironomidae	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase
Functional Feeding Groups (FFG)		
Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers	Percent of macrobenthos that filter fine particulate matter	increase
Percent Grazers	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	decrease
Abundance		
Estimated Abundance	Estimated number of benthic macroinvertebrates in sample calculated by extrapolating from the proportion of organisms in the subsample	variable

Table 6-4. Bioassessment metrics used to describe characteristics of the benthic macroinvertebrate (BMI) community at sampling reaches.

Table 6-5. 2003 Kings River benthic macroinvertebrate (BMI) survey results.

	Kings River Reach 1 (Control)			Kings River Reach 2 (Control)			Kings River Reach 3 (partial control)			Kings River Reach 3b (gravel augmentation)		
	Mean	CV	Total	Mean	CV	Total	Mean	CV	Total	Mean	CV	Total
Estimated Abundance	1710.4	5.0	5131.3	1956.8	53.1	5870.4	900.1	29.8	2700.4	1174.0	60.1	3522.1
Taxa Richness	15.7	18.4	24.0	18.3	8.3	29.0	19.7	5.9	23.0	14.0	14.3	20.0
Percent Dominant Taxon	28.1	12.9	28.0	39.3	10.9	39.4	44.3	29.0	47.5	29.8	13.8	28.8
EPT Taxa	6.3	32.9	9.0	7.0	14.3	11.0	6.0	33.3	9.0	4.3	13.3	5.0
EPT Index (%)	37.9	36.0	38.5	28.6	38.6	28.3	10.8	15.7	11.9	28.2	16.8	28.0
Sensitive EPT Index	1.8	95.2	1.9	0.8	21.3	0.8	0.8	68.4	1.0	0.1	173.2	0.1
Ephemeroptera Taxa	4.0	25.0	5.0	4.3	13.3	5.0	4.0	25.0	5.0	4.3	13.3	5.0
Plecoptera Taxa	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.0
Trichoptera Taxa	2.3	65.5	4.0	2.7	21.7	6.0	2.0	50.0	4.0	0.0		0.0
Dipteran Taxa	3.0	33.3	5.0	4.3	35.3	7.0	2.7	21.7	3.0	3.3	34.6	4.0
Percent Dipteran	32.4	11.2	32.3	45.3	6.7	45.3	47.0	27.3	50.4	32.9	18.0	33.2
Non-Insect Taxa	5.3	57.3	9.0	6.0	16.7	10.0	10.0	10.0	10.0	6.0	16.7	10.0
Percent Non-Insect	19.9	37.6	19.6	19.2	59.5	19.5	36.0	33.0	30.9	38.8	4.7	38.7
Percent Chironomidae	31.8	10.6	31.6	43.9	10.2	44.0	46.3	28.2	49.7	32.1	20.6	32.4
Percent Hydropsychidae	17.0	57.0	17.5	14.0	56.0	13.8	0.7	87.8	0.7	0.0		0.0
Percent Baetidae	4.4	113.1	4.6	4.6	58.1	4.5	1.3	81.2	1.4	3.8	66.4	3.7
Shannon Diversity	2.1	7.4	2.2	2.0	2.9	2.1	2.0	12.0	1.9	1.9	5.8	2.0
Tolerance Value	5.2	3.7	5.1	5.5	3.1	5.5	6.1	4.0	6.3	5.0	0.5	5.0
Percent Intolerant (0-3)	1.7	100.9	1.8	0.3	98.5	0.3	0.5	118.0	0.6	0.1	173.2	0.1
Percent Tolerant (8-10)	8.5	45.3	8.5	9.7	22.9	9.8	27.0	49.9	29.5	4.9	43.1	4.8
Percent Collectors	58.4	17.8	58.1	62.3	15.5	62.6	60.8	22.9	58.3	72.4	6.9	72.2
Percent Filterers	17.3	57.9	17.7	14.6	58.7	14.4	1.5	14.2	0.7	0.6	94.1	0.5
Percent Grazers	11.9	16.7	11.8	8.2	23.3	8.1	12.3	21.0	13.6	0.5	29.5	0.5
Percent Predators	8.1	30.9	8.1	10.0	9.0	10.0	23.3	56.4	25.2	23.0	18.2	23.2
Percent Shredders	0.0		0.0	0.0		0.0	0.0		0.0	0.0		0.0

Table 6-5. 2003 Kings River benthic macroinvertebrate (BMI) survey results (continued).

	Kings River Reach 4 (deep ripped)			Kings River Reach 5 (control for site 4)			Kings River Reach 6 (spawning channel)		
	Mean	CV	Total	Mean	CV	Total	Mean	CV	Total
Estimated Abundance	2957.2	30.0	8871.7	4645.4	44.2	13936.3	1613.7	69.2	4841.1
Taxa Richness	22.7	5.1	31.0	24.3	10.3	35.0	20.0	10.0	23.0
Percent Dominant Taxon	28.9	39.9	27.3	30.6	9.4	30.7	32.5	13.8	32.3
EPT Taxa	8.7	17.6	11.0	7.0	14.3	10.0	6.0	16.7	8.0
EPT Index (%)	34.7	30.0	35.0	51.6	4.3	51.7	12.4	18.4	12.4
Sensitive EPT Index	1.0	60.0	0.9	0.8	37.0	0.8	3.1	67.0	3.2
Ephemeroptera Taxa	4.0	0.0	4.0	5.0	20.0	6.0	3.3	17.3	4.0
Plecoptera Taxa	0.0		0.0	0.0		0.0	0.0		0.0
Trichoptera Taxa	4.7	32.7	7.0	2.0	0.0	4.0	2.7	43.3	4.0
Dipteran Taxa	4.7	12.4	6.0	6.7	8.7	9.0	4.0	0.0	4.0
Percent Dipteran	35.3	36.1	35.0	29.4	14.1	29.2	21.3	14.1	21.3
Non-Insect Taxa	8.3	6.9	13.0	9.7	15.8	15.0	9.0	11.1	10.0
Percent Non-Insect	28.1	23.5	28.0	16.9	19.6	17.0	62.6	4.2	62.8
Percent Chironomidae	32.6	41.6	32.4	20.4	10.9	20.4	18.8	20.3	18.8
Percent Hydropsychidae	14.6	56.4	14.9	11.6	22.7	11.6	1.0	95.1	0.9
Percent Baetidae	7.5	28.1	7.6	32.9	8.1	33.0	2.8	28.0	2.8
Shannon Diversity	2.3	7.3	2.4	2.3	3.2	2.4	2.2	5.5	2.3
Tolerance Value	5.4	2.9	5.4	5.3	1.6	5.3	5.6	1.8	5.6
Percent Intolerant (0-3)	0.1	173.2	.01	0.5	39.4	0.5	0.0		0.0
Percent Tolerant (8-10)	11.8	27.2	11.8	9.3	33.4	9.4	13.9	29.9	14.1
Percent Collectors	62.7	9.0	62.5	62.9	3.1	63.0	59.6	10.4	59.5
Percent Filterers	16.1	52.5	16.4	19.0	20.5	18.8	3.3	31.2	3.2
Percent Grazers	4.2	21.2	4.2	4.4	58.3	4.4	20.8	22.2	20.8
Percent Predators	11.0	38.6	10.9	10.9	16.8	11.0	13.3	25.6	13.5
Percent Shredders	0.0		0.0	0.0		0.0	0.0		0.0

Results of the 2003 FMP macroinvertebrate surveys show a consistent pattern with the indices within the general range of poor conditions (taxa richness, tolerance value) or average conditions (average EPT index (%), average percentage dominant). The indices at Site 3b, where gravel augmentation occurred, were generally low and were not substantially different from the indices at site 3a (control), where gravel augmentation had not occurred. The similarity in macroinvertebrate communities at Site 3 with and without gravel augmentation may reflect the relatively short time period that the gravels had been in the river prior to sampling and/or sampling during the winter months (the biological response of the macroinvertebrate community to variation in habitat conditions may be reduced during colder winter months when compared to spring or summer conditions).

Another way of looking at the data is to compare the "good" bugs to the "bad" bugs. There presence or absence is a response to changes in conditions as detailed in Table 6-2. Good and bad are relative terms, but again, the "good" bugs are indicator of good habitat quality while the "bad bugs" represent degraded habitat quality. Table 6-6 compares the EPT index (Ephemeroptera, Plecoptera, and Trichoptera = "good bugs") to the CRAP index (Chironomid larvae, round worms, annelid worms and Platyhelminthes worms = "bad bugs") in percentage composition in the various samples. It is clear from the comparison of these two indices that the CRAP index is consistently higher than the EPT index, indicated a degraded environment for macroinvertebrates.

Table 6-6 – Comparison of the EPT and CRAP indexes for macroinvertebrates samples collected from the lower Kings River in 2003.

Site Type	Sample Number	EPT or PET Index (%)	CRAP Index (%)
Control	KR 1-1	23.5	57
	KR 1-2	39.5	37
	KR 1-3	50.6	35
	KR Total 1	38.5	43
Control	KR 2-1	29.5	52
	KR 2-2	17.1	67
	KR 2-3	39.2	41
	KR Total 2	28.3	54
Gravel Project	KR 3-1	8.9	63
	KR 3-2	11.8	60
	KR 3-3	11.8	38
	KR Total 3	11.9	58
Gravel Project	KR 3a-1	23.0	68
	KR 3a-2	29.4	63
	KR 3a-3	32.3	58
	KR Total 3a	28.0	63
Deep-rip Project	KR 4-1	46.0	39
	KR 4-2	32.8	46
	KR 4-3	25.4	61
	KR Total 4	35.0	48
Control	KR5-1	54.1	28
	KR 5-2	49.8	30
	KR 5-3	50.8	25
	KR Total 5	51.7	27
Thorburn Channel	KR 6-1	13.0	45
	KR 6-2	14.4	51
	KR 6-3	9.9	60
	KR Total 6	12.4	52

PET = Plecoptera (stoneflies), Ephemeroptera (Mayflies), and Trichoptera (Caddisflies).

CRAP = Chironomid larvae, Round worms, Annelid worms, and Platyhelminthes worms.

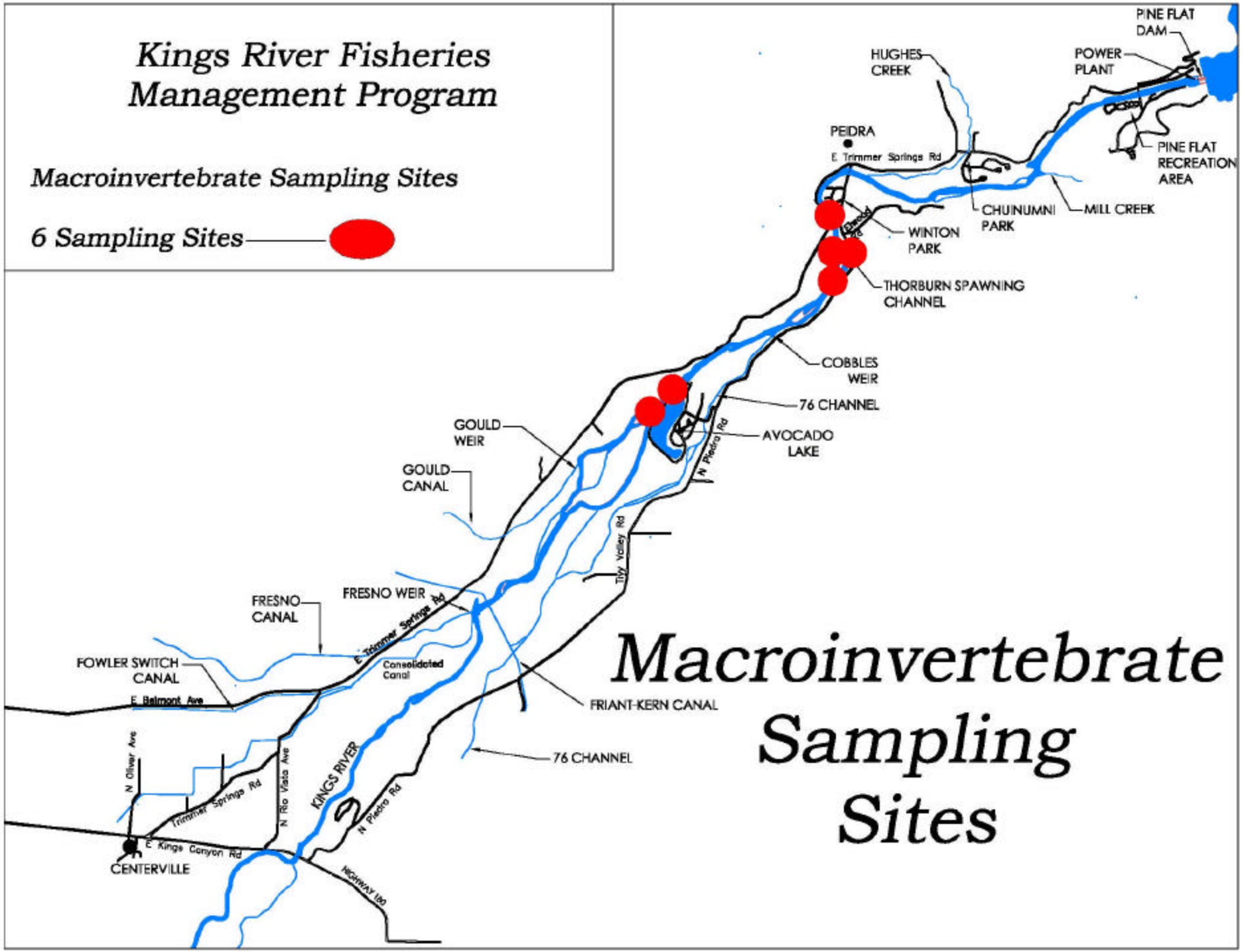


Figure 6-4 Macroinvetebrate sampling sites.

1973-1974 Burdick Study

There were many things different about the 1973-1974 Burdick study that makes it difficult to compare to the FMP's 2003 study. However, some information from that study can be compared to the current study. We are able to use some of this earlier data to compare to the current study. Table 6-7 compares the numbers of taxa found in the two studies.

Taxa Found	1974 Burdick	2003 FMP
Ephemeroptera (may flies)	6	6
Trichoptera (caddis flies)	8	7
Diptera (fly flies)	12	7
Plecoptera (stone flies)	3	0
Non-insect	Undetermined	15

Table 6-7. Comparison of the number of taxa found between Burdick 1974 study and the FMP's 2003 study.

Table 6-8 compares the EPT and CRAP indices by date (we don't have an accurate account of sampling locations).

Date	EPT Index (%)	CRAP Index (%)
April 16, 1973	30.4	42.5
April 30, 1973	34.7	47.3
May 13, 1973	31.7	60.1
May 18, 1973	32.0	52.2
June 11, 1973	36.5	46.1
Mean	33.1	49.6

Table 6-8. Comparison of the EPT and CRAP indices for the Burdick study.

Discussion

2003 FMP Study

Based on preliminary results of the winter 2003 macroinvertebrate study it appears that the existing macroinvertebrate community would generally be characterized as reflecting a stressed and/or degraded riverine habitat condition. The lack of habitat diversity within the lower Kings River in combination with other environmental conditions may be factors limiting diversity of macroinvertebrates inhabiting the lower river.

Comparison of Burdick 1974 and FMP 2003 Studies

Surprisingly, the data we could glean from the 1973-1974 Burdick studies is similar in many ways to the current study. It appears that there has been a slight decline in the EPT index and a

resulting rise in the CRAP index between the earlier and current study. However, this could be due to the relatively small sample size in both studies.

Recommendation

Based on the preliminary results of these surveys, it is recommended that additional macroinvertebrate surveys be performed with modifications to the sampling design. Modifications to the study design includes dispersing sampling stations over a wider area of the lower Kings River extending from Pine Flat Dam downstream to Highway 180. Sampling sites would be selected based on habitat conditions representing various reaches of the river.

Surveys should also be conducted at several times within the year to reflect seasonal variation in the species composition and abundance of macroinvertebrates inhabiting the river. Investigation should continue to compare the macroinvertebrate community response to habitat enhancement actions, such as the boulder and gravel augmentation areas, for comparison with similar habitats within the area where enhancement has not occurred. In addition, the surveys should be expanded to include an upstream reference/control site, located upstream of Pine Flat Reservoir, which would provide useful information for evaluating results of macroinvertebrate collections within the lower river downstream of the dam.

6.2.7 Algal Die-Off

The TSC received anecdotal observations during 2002-2003 from several anglers reporting algal die-offs within reaches of the lower Kings River. Changes in the algal populations within various reaches of the river could not be confirmed. In response to concerns raised by the PAG and others regarding health and condition of algae the TSC has developed and implemented a rapid response approach to conducting field observations in response to reports of algal die-offs within the river. A protocol has been established for the rapid response based upon notification of the TSC of such an event by anglers or the public. In addition, efforts have been initiated by a California State University Fresno student to conduct reconnaissance level surveys of the algal community within the lower Kings River and to characterize species composition, general geographic distribution, and overall condition of algal populations, on a seasonal basis, within the river. Results of these activities will provide additional insight into factors affecting lower trophic levels, including algae, and as discussed above for macroinvertebrates, which represent important components of the aquatic community inhabiting the river. Algal monitoring was initiated during the fall of 2003 following completion of the irrigation season.

6.2.8 Trout Tagging Studies

Mark-recapture studies using reward tags were conducted as part of the adult trout stocking program evaluation during 2002-2003. Separate tag codes were used to identify the date and location of release and the location of recapture. Results of the tagging study have been used to estimate trout harvest rates, survival, movement, and geographic distribution within the lower

Kings River. The mark-recapture techniques also provide information useful in evaluating alternative planting strategies for trout produced in hatcheries and subsequently released into the lower Kings River. Recapture of marked trout occurred by recreational anglers.

Tagging studies in 2001-2002 were conducted in the area where catchable size trout were released for angler harvest. The experimental design for the 2002-2003 study included releases of three groups of tagged fish at three locations from the dam downstream to Highway 180. The areas are: 1) the ACOE Bridge downstream to Cobbles Weir (in the general vicinity of Winton Park); 2) Cobbles Weir to Fresno Weir; and 3) Fresno Weir to Highway 180. Tagged catchable trout were released in small groups from June through December 2002. A total of approximately 2,100 trout were tagged and released. Approximately 700 tagged trout were released in each of the three areas. Within each release area approximately 350 of the tagged trout were released during the high flow irrigation season and 350 fish were released into each reach during the low flow period after completion of the irrigation season. Tagged fish were stocked in each reach every other week. Every attempt was made to tag and release all three groups of fish on the same day or within one day of each other. Fish were tagged the day of planting due to space limitations at the hatchery.

Catchable trout released as part of this study were tagged with Floy tags, which are much easier and quicker to use than the Carlin tags used in 2001-2002. Due to the relatively short nature of the study, and the relatively short time period over which tagged fish from last year returned, we believe the use of Floy tags is appropriate. Reward tags were marked with the address of the "Department of Fish and Game at 1234 E. Shaw Avenue". Tags were returned by the anglers to CDFG, and the reward paid from funds CDFG has committed to the Kings River as part of the Framework Agreement.

The return of tags from fish has virtually ceased. However, due to the small number of returns from some aspects of the tagging program, critical analysis of the data with low return rates will not produce dependable results. However, the first set of tagging studies in January of 2002 produced some interesting observations, and relatively large returns of tags.

Preliminary results from the tagging studies in January 2002, with Carlin tags showed return rates that varied from 20 % to 49.3 %. The upper section near the dam (Pine Flat Dam to Alta Weir – Section 1) and the lowest section (Fresno Weir to Hwy 180 – Section 3) had return rates of 45.0 % and 52.7 % respectively. The middle section, from Alta Weir to Fresno Weir (Section 2) had a lower return rate of 22.7 %.

It appears that fish tagged during this time of the year all stayed where they were stocked or moved upstream, based on anglers reports of the areas they caught the trout. There may be some mis-reporting of the areas where the fish were caught, but a number of different anglers were involved in reporting the areas of catch. Therefore, the general trend of the fish staying put or moving upstream is probably an accurate reflection of what fish did at the low flow period of about 97 cfs (average 30 day post planting flow).

Return rates for fish stocked in June of 2002, November of 2002, and April of 2003 (2 plants) were 10 %, 16 %, and 20 % and 28 % respectively. These plantings were all of 50 fish per site. It appears from the initial data that catch rates are highly variable. This may be due to the low

number of tagged fish that were stocked, low returns due to low angler use or higher flows (June, and April) that may have made fish harder to catch, or move out of the area where they were stocked, or other causes. However, even during the plant of November 2002, when the flow averaged 105 cfs and the flow range was not significantly different from January 2002, returns were relatively low indicating that other factors were probably in part responsible.

In the future any stocking of tagged catchable trout in this section of the river should be comprised of larger groups of fish. Based on the plant of January 2002, the number of fish should be in the range of 150 to 200 tagged fish per site to get enough tags returned to have a higher level of confidence in the values.

It appears that at very high flows the catch of trout may be reduced. However, due to the low returns and high variability in the return rates, and the fact that some fish were stocked in different areas, no definitive results were documented from this part of the study with the current level of analysis and data available.

Planting Date	% Return	Release Flow (cfs) 30 day post planting average
1/1/02	45%	97
1/1/02	23%	97
1/1/02	53%	97
6/1/02	10%	6039
11/1/02	16%	105
4/3/03	20%	772
4/15/03	28%	1154

Table 6-9 – Summary of trout tagging studies.

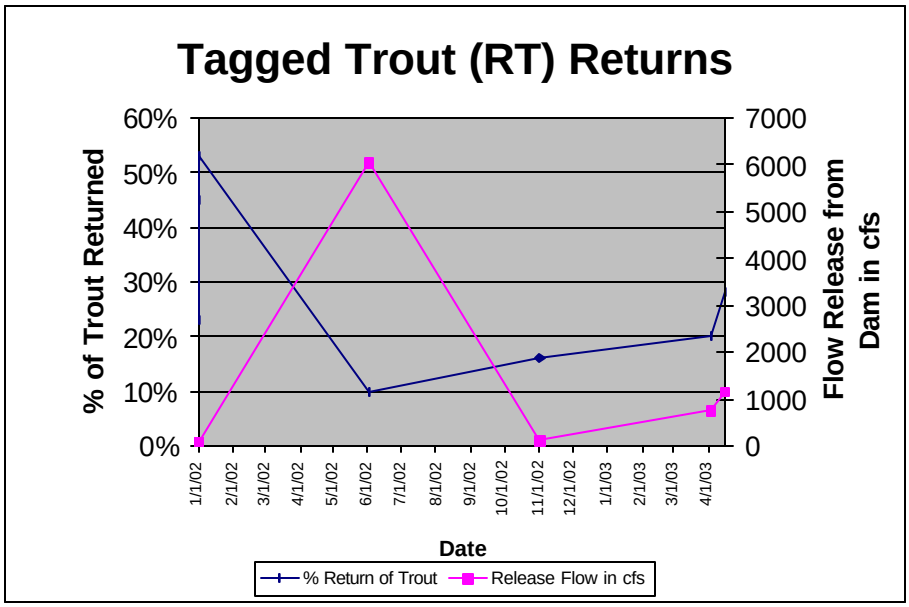


Figure 6-5 – Summary of trout tagging studies.

6.2.9 ANGLER LOGBOOKS

As part of the fishery monitoring program, log books were distributed to local recreational anglers for use in recording information on the areas fished, duration of each fishing trip, numbers, species, and sizes of trout and other fish caught, and other information valuable in characterizing angler harvest success and developing indices of trout abundance and distribution. Data from the logbooks was also used to evaluate seasonal patterns in fishing success and the harvest of catchable trout stocked in the river. Results of the angler log books supplement monitoring results from conventional fishery survey methods used in sampling adult trout within the lower river.

Angler notebooks, including daily survey forms (Figure 6-6), were distributed to recreational anglers to record information on the species, length frequency distribution, catch per unit of effort (CPUE: catch per hour), and angler harvest within each of the three management reaches. Angler survey notebooks were distributed during 2000-2001, 2001-2002, and 2002-2003, which provided useful monitoring information, particularly on adult trout distribution and abundance. Results of the angler surveys are compiled each year and used to develop an index of adult trout abundance (CPUE) by reach for use in evaluating trends in the trout population among years. Results have also been used to develop an assessment of over-wintering survival of adult trout and an index of adult trout abundance each spring representing adult brood stock and reproductive potential of the adult population. The angler surveys are also being used to assess the relative abundance of both rainbow and brown trout, in addition to other species inhabiting the river.

Members of the TSC have heard stories and seen photographs of large (greater than 16 inches) rainbow trout reportedly caught by anglers on the lower river in recent years. This data is contrary to standard electrofishing survey techniques used to sample the fish population. In an effort to determine angler success, an angler diary was developed by the TSC. The idea was that this booklet would be handed out to selected anglers who were reported to be average or better anglers. These anglers would record the results of each angling trip in this angler logbook. Instructions were printed on the front cover and anglers were encouraged to record all angling days results, even days where no fish were caught. The booklet was printed on waterproof paper and was small enough to fit in a pocket. The booklets are all stamped with a number and no name is associated with the booklet, other than a master list maintained by CDFG. The theory was that without having a name associated with the booklet, anglers would be more accurate in recording their angling results. The anglers would use these logbooks during the angling season and the booklets would be collected from the anglers once the flows increased and the lower river became difficult to fish (March). To date, 60 angler logbooks have been issued to anglers. Almost all of these anglers have been associated with the PAG or organized angling clubs (i.e. fly fishing organizations). The information in the booklets has been summarized on an annual basis and forms the basis for a trend analysis of the fishery using a unique technique providing information not normally available to the TSC on the quality of one important aspect of the fishery.

Anglers have been contacted (including individual letters to holders of the booklets), requesting that the logbooks either be mailed or dropped off at the CDFG office in Fresno for recording. Data was recorded from the booklets and then they were returned to the angler. We have had difficulty in getting anglers to return the logbooks to the TSC for analysis. In 2000 sixteen books were returned, in 2001 fourteen books were returned; in 2002 12 logbooks were returned.

Because of concerns about the low return of angler log books, the TSC decided to offer prizes for the return of angler logbooks in 2002-2003. A set of rules for the drawing were developed and sent to holders of angler logbooks. A drawing of three names from anglers that had returned angler logbooks to the CDFG by June 2002 was held to award three prizes of $100 each. The drawing was held at the June 20, 2002 meeting of the PAG and the prizes were awarded. However, only twelve angler logbooks were returned in 2002 and it was concluded offering prizes for the return of the booklets was not effective as an incentive for completing and returning the logbooks. Based on results from 2002 the TSC has recommended that prizes not be used as an incentive in the future.

Despite the low return of the booklets, some valuable information has been obtained (Table 6-10). Although the sample size is low the results appear to be consistent. Most anglers are recording outings where no fish are caught. This is encouraging and indicates the data has validity. The combined catch rate for all three years is 0.518 fish per hour. The length frequency of trout caught and reported by anglers (Figure 6-7) shows that the greatest numbers of trout ranged in length from 10 to 18 inches.

Date fished _____ Number of hours fished_____

Check ONE: Gear used primarily: bait_____ lure_____ fly _____

Number of rainbow trout kept _____ released _____

Number of _____ kept _____ released _____

SECTION FISHED: *** IMPORTANT *** Check ONE section fished.
Use **SEPARATE FORMS** for each section fished on the same date.

_____ From Pine Flat Dam to Choinumni Park
_____ From Choinumni Park to Cobbles (Alta) Weir
_____ From Cobbles Weir to Gould Weir
_____ Avocado Side Channel
_____ From Gould Weir to Fresno Weir
_____ Fresno Weir to Highway 180 Bridge
_____ From Highway 180 Bridge to Sanger
_____ From Sanger to Reedley
_____ From Reedley to Kingsburg
_____ Pine Flat Reservoir

SIZE OF FISH: Enter **NUMBER** of each species caught by sizes

	Rainbow Trout		_____	
	Kept	Released	Kept	Released
Less than 6"	_____	_____	_____	_____
6" - 7.9"	_____	_____	_____	_____
8" - 9.9"	_____	_____	_____	_____
10" - 11.9"	_____	_____	_____	_____
12" - 13.9"	_____	_____	_____	_____
14" - 15.9"	_____	_____	_____	_____
16" - 17.9"	_____	_____	_____	_____
18" - 19.9"	_____	_____	_____	_____
19" - 20.9"	_____	_____	_____	_____
21" - 21.9"	_____	_____	_____	_____
22" and greater	_____	_____	_____	_____

Figure 6-6. Example page from the angler logbook.

RT = rainbow trout

BN = brown trout

Year	No Anglers	No. Hrs. Fished	RT Released	RT Creeled	BN Released	BN Creeled	Catch/ Hr.
2000	16	241	181	1	0	0	0.755
2001	14	465	227	20	1	0	0.533
2002	12	102	10	0	6	0	0.157
Total	42	808	418	21	7	0	0.552

Table 6-10– Summary of trout reported to be caught from angler logbooks between 2000 and 2003 within the lower Kings River.

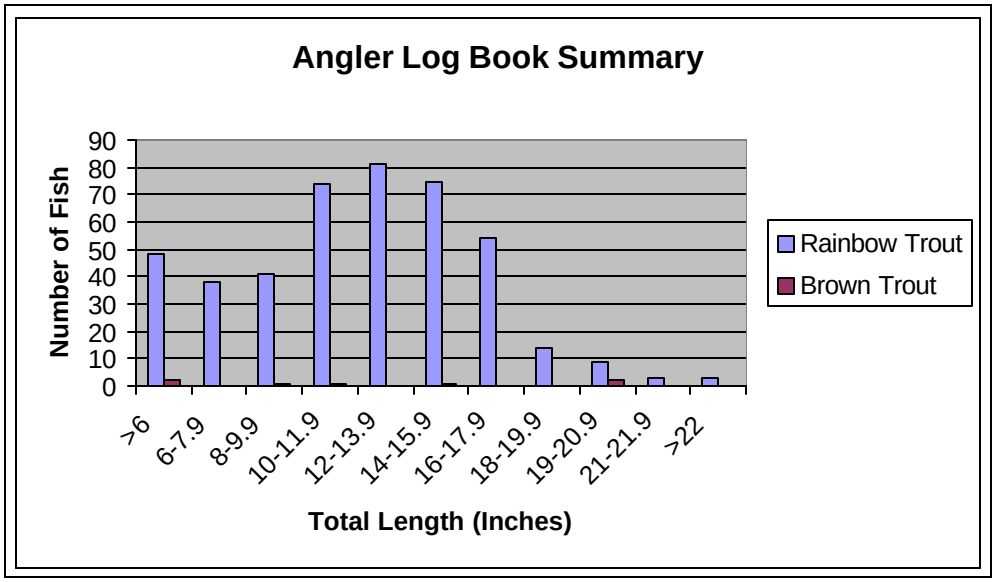


Figure 6-7. Length-frequency of trout reported caught in angler logbooks between 2000 and 2002 from the lower Kings River.

6.3. RESERVOIR

Recreational fishing at Pine Flat Reservoir is a popular reservoir recreational activity and important to the local anglers and the economy. The CDFG stocks a variety of hatchery-produced fish, in relatively large numbers each year, in the lake to enhance angling opportunities. In addition, the Kings River Framework Agreement identifies the expenditure of funds to enhance the fishery. Monitoring of the fish populations and angler success occurs annually by CDFG biologists to assess trends in abundance of game and non-game fish species. Pine Flat Reservoir was sampled in the spring and the fall by CDFG biologists to determine fish species composition and sizes. Angler surveys were conducted monthly throughout the year to gain information on angler success and fish species caught. The angling regulation for black bass at Pine Flat Reservoir has a creel limit of five bass, minimum of 12 inches in length. The reservoir also supports a popular coldwater fishery, supported largely by stocked rainbow trout and chinook salmon. Sampling the fish population involves several standard methods, including the setting of gill nets to evaluate the sporadic reports of white bass occurrence in the lake. Each sampling method is selective for certain types of fish. This is the reason for the need to use multiple sampling methods and the results all need to be considered when evaluating the condition of the fish population in the reservoir. Monitoring activities that occurred within the reservoir during 2002-2003 are briefly discussed below.

6.3.1. Gill Netting

Once each year fishery surveys are conducted at designated sampling sites within Pine Flat Reservoir using experimental (multiple mesh sizes) monofilament gill nets. Gill nets were set on a series of nights, over a three-night period, and usually left until daybreak when the nets were retrieved and the fish processed.

Results of the gill net surveys provide an independent estimate of species composition and relative abundance (catch per unit of effort) for both game and non-game species inhabiting the reservoir. The most common fish caught in the gill nets were white catfish followed closely by Sacramento pike minnow, rainbow trout, threadfin shad, largemouth bass, western suckers, black and white crappie, and spotted bass. Small numbers of carp and bluegill were also recorded. Results of the 2002 surveys were basically identical to 2001 fishery surveys.

6.3.2. Boat Electrofishing

At least once each year, boat electrofishing surveys are conducted within Pine Flat Reservoir to provide information on the species composition and relative abundance of both game and non-game fish species. Electrofishing is conducted over a period of approximately three days each year within designated sampling areas. The sampling areas and collection methods have been standardized to facilitate comparison of results among years. Data from the electrofishing surveys include information on species composition, relative abundance, and length frequency for both predatory game species and non-game prey species.

Electrofishing surveys during 2001-2002 (Figure 6-8) recorded spotted bass (SPB) comprising up to 33% of the fish population followed by threadfin shad (TFS), largemouth bass (LMB), blue

gill (BG), white catfish (WCF), green sunfish (GSF), and native Sacramento pike minnow (SPM) contributed to the fish collected. The species composition of the fish community inhabiting Pine Flat Reservoir is typical of similar reservoirs in the Central Valley.

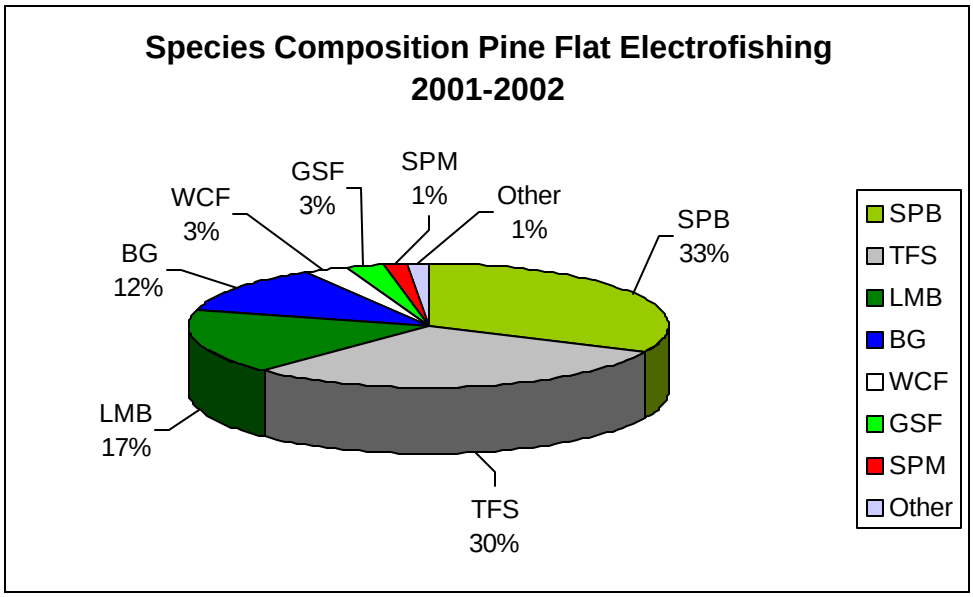


Figure 6-8 – Species composition found during boat electrofishing surveys of Pine Flat Reservoir

6.3.3. Bass Tournament Results

The CDFG requires organized angling tournaments, including those for largemouth bass, to obtain either an event or annual permit. The sponsor of the tournament is required to provide the CDFG with a report of the results of the tournament. The CDFG summaries tournament results in an annual report that covers the entire State. The report includes the date of the tournament, the number of participants, the length of the tournament (hours) and the number and weight of fish weighed-in. From this information, calculations of angler success (fish per hour or pounds per hour) can be made. Data from these records have been complied for Pine Flat Reservoir to develop an estimate of bass abundance (catch per unit of effort) from individual tournament results and as an annual composite index for use in assessing trends in the population over time and in response to variation in reservoir operations.

Numerous studies have shown that the results from bass tournaments are a good indicator of success of non-tournament anglers (Doleman 1991; Ebbers 1987; Farman et al. 1982; Gablehouse and Willis 1986; Schram et al. 1991 and Willis and Hartmann 1986). Based on this strong correlation between tournament angler success and that of the average angler, this is a valuable, low cost tool for monitoring the condition of the fish populations and angler success within the reservoir.

During the period from 1985-1993, the average catch per angler hour during tournaments was 0.191. The mean weight of the bass caught and released was 1.35 pounds (CDFG, unpublished data). Since this is the first annual report, data from 2000 and 2001 are also included along with 2002 and part of the 2003 data for trend analysis purposes. During 2002 through the first part of 2003, there were 78 organized and permitted bass tournaments scheduled or held at Pine Flat Reservoir (Table 6-11). Of these tournaments, the CDFG has received useable reports from 31 tournaments (25 in 2002 and 6 in 2003). Some of the tournaments held in 2003 have been recently completed and reports are not yet due.

Year	2000	2001	2002	2003 (so far)
No. Tournaments	31	16	25	6
No. Anglers	942	525	798	167
No. Hours Fished	244	143	243	50
Total No. Bass	1,586	1,160	1,981	458
Total Weight (Pounds)	1,871	1,863	3,479	780
Hrs fished/angler	7.87	8.94	9.42	8.33
Total Hours	7,714	4,694	7,168	1,404
Avg. per bass (pounds)	1.18	1.61	1.69	1.70
Catch/Hr.	**0.206**	**0.247**	**0.276**	**0.326**

Table 6-11 – Summary of organized bass tournaments at Pine Flat Reservoir 2000 through 2003 (incomplete data in 2003).

6.3.4. Angler Creel Census

Anglers at Pine Flat Reservoir were periodically interviewed by a CDFG employee to determine trends in angler success and the fishery. The employee would move around the reservoir in a boat contacting as many anglers as possible in an eight hour day. A similar survey was conducted on other central valley reservoirs by the Region 4 Reservoir Biologist and his staff. Anglers were asked a series of questions to determine their angling effort (hours fished) and success (fish landed, kept and released by species). Fish were measured and weighed when possible. All data was recorded on a standard CDFG creel survey form and summarized in an annual report. This is a very small sample and daily angler success is highly variable. The results should be considered for trend comparison only.

1999-2000

During the period from July 1999 through June 30, 2000, surveys occurred on 23 days. Four hundred and eighty-seven anglers were contacted who had fished a total of 2,215 hours (Table 6-12). They caught 851 fish (0.384 fish per hour), 553 of which were released alive. The fish landed consisted of black bass (55%), salmonids (34%) and other species (11%). The CPUE of 0.384 fish per hour observed at Pine Flat Reservoir was slightly lower than the average catch per hour of 0.59 from six other valley reservoirs for the same period (range 0.37-0.89 fish per hour).

2000-2001

Two hundred and sixty-four anglers on Pine Flat Reservoir were contacted on 16 days during the July 1, 2000 through June 30, 2001 period. They had fished a total of 1,159 hours and landed 420 fish (0.362 fish per hour) and released 228 fish. The fish landed consisted of black bass (56%), salmonids (44%) and other species (<1%). This compares to an average catch rate of 0.36 fish per hour at nine other valley reservoirs (range 0.14-0.59 fish per hour).

2001-2002

One hundred and Fifty-one anglers were interviewed during11 days of creel survey during the 2001-2002 period. They had fished a total of 615 hours and landed 194 fish (0.315 fish per hour). Ninety-four of the fish landed were released alive. Of the fish landed, spotted bass (43%) and rainbow trout (43%) were the most frequently caught fish followed by largemouth bass (8%), white catfish (3%), bluegill (2%) and chinook salmon (1%) (Chin) (Figure 6-9). This compares to a average catch rate of 0.303 fish per hour at nine other central valley reservoirs during the same period (range 0.19 – 0.39 fish per hour).

2002-2003

For the 2002-2003 survey period, seven anglers were contacted during one day of creel survey. They had fished a total of 10 hours and landed 2 fish (0.2 fish per hour). Both fish landed were trout and no other fish were seen during the survey. This is such a small sample that it does not reflect the fishery and the effort and results should be ignored.

Period	No. anglers	No. Hours	LMB per Hour	Salmonids per Hour	Other fish species per hour	Total fish per hour
1999-2000	487	2,215	0.213	0.131	0.04	0.384
2000-2001	420	1,159	0.201	0.160	0.001	0.362
2001-2002	151	615	0.161	0.14	0.014	0.315
2002-2003	7	10	0	0.2	0	0.2

Table 6-12 – Summary of angler effort and catch rate at Pine Flat Reservoir for the period July 1999 though June 2003 as determine by an occasional roving creel survey (CDFG unpublished data)

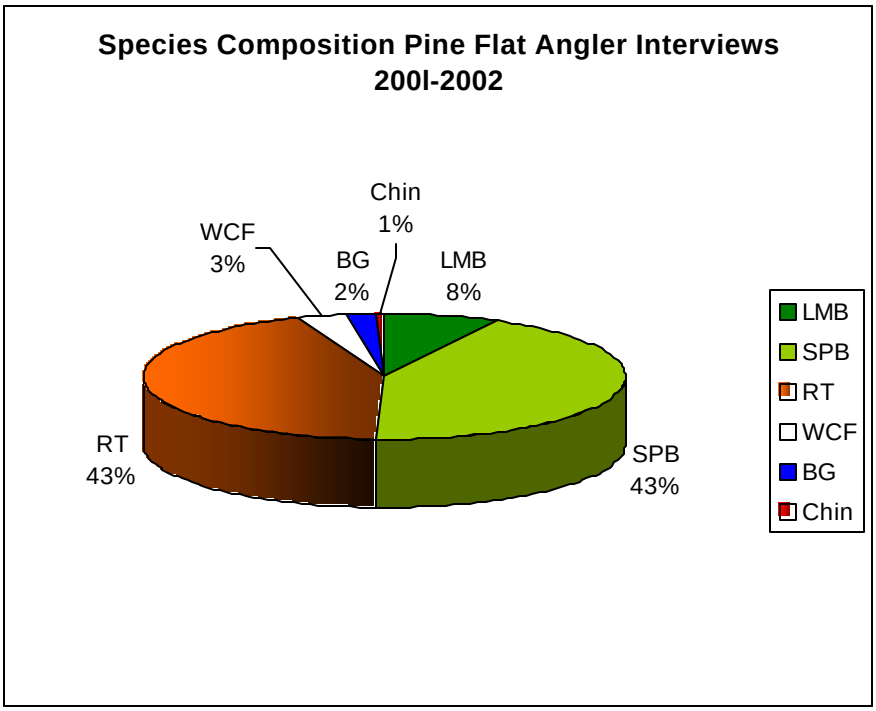


Figure 6-9 – Fish species composition based on angler interviews at Pine Flat Reservoir.

6.3.5 Summary and Discussion

Our goal was to conduct fish population surveys within the lower Kings River at the end (December) and prior to (March) the irrigation releases. The goal was to develop information on the carry over of trout during the low flow period. While the end of season monitoring occurred, the pre-irrigation monitoring did not. The December 2002 electrofishing results were similar to previous years, with low numbers of small trout captured at most sites. Very few of the 36,000 juvenile hatchery marked trout were captured, indicating they are either dying, leaving the area, or not effectively sampled using current monitoring techniques. It is possible that the larger trout are in deeper water not available to sampling with backpack electrofishers. The fact that the larger trout are reported in the angler logbooks and by PAG members and other recreational fishermen, although in relatively low numbers, supports this theory, and few subcatchable or adult trout were observed in deep pools during past snorkeling surveys in the 1990's. Non-game fish continue to dominate the fish population in terms of both numbers and biomass. It appears that low recruitment of trout to the population continues to be a limiting factor for the fishery.

We conducted pre- and post-project monitoring on the coves and jetties project. The two3 inch long trout captured at the Pine Flat Recreation site pre-project sampling were both behind a large sycamore tree, which was providing instream habitat and cover. Low numbers of other fishes were captured during the pre-project sampling. High velocities prevented fish from using the streamside habitat. It is clear that post-project monitoring occurred too late in the year. Young-of-the-year trout were observed by KRCD biologists using the coves and jetties in April 2003. We did not sample the construction site until late August 2003 and any trout would have most likely grown to an adequate size to seek deeper water. Sampling in 2004 needs to occur during the April-May period. A fair number of non-game fish were collected during the post-project monitoring of the coves and jetties. Most of these fish were utilizing the upstream side of the jetties. We believe additional sampling needs to occur earlier in the year to better evaluate the use of these structures by juvenile trout. However, no additional coves and jetties should be constructed until an accurate evaluation has occurred.

Backpack electrofishers limit sampling to wadable water depth with low to moderate velocity. Often, trout seek the cover of deep pools during low flow periods. This deeper water has gone unsampled with the exception of angling by the public and snorkeling surveys conducted by the KRCD in the 1990's. We believe that the absence of sampling in deeper water habitats is largely responsible for the differences we see between backpack electrofishing and angler log book reports. Anglers are fishing these deeper waters. In 2004 we will conduct the trout population estimates using the electrofishing raft to survey deeper water habitats. Hopefully this will provide some insight into the adult trout inhabiting deeper water, including areas adjacent to boulder projects.

It is important to note that during our annual electrofishing survey, we almost always find trout hiding in the boulder clusters. While it is impossible to know if this is preferred habitat or they were chased into these structures, our belief is that the boulder clusters provide very desirable habitat and the addition of boulder clusters to the river is a desirable activity.

The Thorburn spawning channel is functioning well as habitat for young fish, including trout. There are no indications that it is being used by adult trout for spawning. We will continue to add additional instream habitat and overhead cover to the channel. We hope to install half-logs or similar structures in the channel in 2004 in hopes of providing desirable holding habitat for adult trout.

A total of 2100 tons of spawning gravel was added to the lower river during the 2002-2003 reporting period. Our preliminary observations have led us to conclude this is a very positive improvement project and needs to continue. In addition to the possible improvement in trout spawning, visual observation (and macroinvertebrate sampling results) indicate the gravel has resulted in an increase in the numbers of macroinvertebrates. We do not have a report from DWR yet, but this survey report will provide important information on the movement and longevity of the gravel in the system. We will attempt to conduct spawning surveys during 2004 to see if the added gravel is being used by trout for spawning.

At the urging of the members of the PAG, macroinvertebrate sampling was conducted at 7 sites downstream of Pine Flat Dam in February and March 2003 to assess the quantity and quality of macroinvertebrates inhabiting the lower Kings River. Macroinvertebrates are an important component in the food chain and serve as food for trout. Based on preliminary results of the winter 2003 macroinvertebrate study it appears that the existing macroinvertebrate community would generally be characterized as reflecting a stressed and/or degraded riverine habitat condition. The lack of habitat diversity within the lower Kings River in combination with other environmental conditions may be factors limiting the diversity of macroinvertebrates inhabiting the lower river. Upon comparing our FMP 2003 study to that of Burdick (1974), it appears that there has been a slight decline in the EPT index and a resulting rise in the CRAP index between the earlier and current study. However, this could be due to the relatively small sample size in both studies.

Based on the preliminary results of the macroinvertebrate survey, it is recommended that additional macroinvertebrate surveys be performed with modifications to the sampling design. Modifications to the study design includes dispersing sampling stations over a wider area of the lower Kings River extending from Pine Flat Dam downstream to Highway 180. Sampling sites would be selected based on habitat conditions representing various reaches of the river. Surveys should also be conducted at several times within the year to reflect seasonal variation in the species composition and abundance of macroinvertebrates inhabiting the river. Investigation should continue to compare the macroinvertebrate community response to habitat enhancement actions, such as the boulder and gravel augmentation areas, for comparison with similar habitats within the area where enhancement has not occurred. In addition, the surveys should be expanded to include an upstream reference/control site, located upstream of Pine Flat Reservoir, which would provide useful information for evaluating results of macroinvertebrate collections within the lower river downstream of the dam.

We have developed a plan to address concerns regarding the algae die-off reported by anglers in 2003. The key to the success of any investigation into the cause and extent of the die off is immediate reporting of the event by anglers to KRCD. In the past, we have learned of the die-off months after it is reported to have occurred.

During the 2001-2002 period, catchable sized rainbow trout planted in the lower Kings River were tagged with $5 Reward tags to estimate the return of fish to the angler. The assumption is made that all tagged trout captured by anglers are returned. We know this is not correct and that some tags are kept or tagged fish are released. However, based on the results of this study, return rates ranged from 22.7% to 52.7% with a mean of 40% return. This means that of the trout planted in the lower Kings River during this period, approximately 40% of these trout are being caught by anglers.

The period 2002-2003 marks the third year of the use of angler logs books to monitor angler success. While this is a valuable tool, it needs to be energized in some fashion. We enjoyed good angler cooperation for the first two years, but by 2002 it was obvious that anglers were losing enthusiasm with the reporting process. This program was initiated because anglers were showing us pictures of large trout they were catching on the lower river. These were trout not detected in our electrofishing surveys . The survey methods have been modified to include sampling deep water habitat using the electrofishing raft to more effectively sample larger trout inhabiting the lower river. The angler logbook reporting compliments the electrofishing surveys and provides a valuable monitoring tool and important information on larger adult trout inhabiting the river.

We feel comfortable with the angler logbook 2000 through 2003 results (Table 6-4), although there is an apparent downward trend in catch per unit effort observed in 2003. There was also a downward trend in the numbers of anglers willing to participate as well as the hours reportedly fished in 2003. There was also a drastic decline in the catch rate reported for 2003. A $300 cash raffle held in 2002 in an effort to increase angler participation was unsuccessful and should not be repeated. If this program is to continue, we need to get additional logs books into the hands of anglers. This is an extremely small sample size, although experienced anglers who should be representing the best possible results are using the books.

We are pleased with the warmwater fishery at Pine Flat Reservoir and believe it is in good condition with an upward trend in both CPUE and size of bass being caught in the recreational and tournament fisheries. It is important to remember that each type of sampling gear has an inherent bias toward various parts of the fish populations and sampling results must be combined to get the best picture of the status of the fishery. The results of electrofishing surveys show that largemouth bass (17%) and spotted bass (33%) comprise a significant part of the fish sampled. In addition, threadfin shad, a primary food source for bass, are also abundant. The food base is good, with 30% of the catch consisting of threadfin shad. The creel census again showed that spotted bass (43%) and rainbow trout (43%) comprised a large part of the anger creel. All this, combined with an upward trend in the catch per hour seen in bass tournaments, lead to the conclusion that this is a quality fishery. Habitat improvement efforts should continue in support of this fishery.

Gill netting results found white catfish to be the most numerous species caught within the reservoir. Most of the sampling occurs in the open water environment and most centrarchids (bass and their relatives) are not highly susceptible to gill nets. It is important to remember that

all sampling gear is biased to some degree and it is important to look at all sampling techniques when evaluating the fishery.

Between 1985 and 1993, the average catch rate during bass tournaments was 0.191 bass per hour and the mean weight was 1.35 ponds (CDFG, unpublished data). The results from recent bass tournament show a generally increasing trend (0.206 in 2000 to 0.326 in 2003) in catch per effort. The mean size of bass reported from tournament records from 2000 to 2003 (Table 6-11) also show a general increasing trend in bass size (1.18 in 2000 to 1.7 pounds each in 2003). Results from recent tournaments indicate that both CPUE and bass size have shown an increase when compared to results from 1985-1993 records.

The results of an occasional creel survey of anglers from Pine Flat Reservoir found that spotted bass and rainbow trout accounted for 43% and 43% of the fish creeled. Rainbow trout are only seasonally available, so this data is slightly biased by time of year of the survey. Largemouth bass accounted for 8%, white catfish 3%, and bluegills 2% of the angler harvest. Typical of most reservoirs, white catfish is an underutilized resource. When the electrofishing and angler survey data are compared, it appears that largemouth bass and bluegill are not being creeled in portion to their presence in the population. It is also worth noting that the world record spotted bass was caught May 3, 2002 in Pine Flat Reservoir by Brian Shishido and weighed in at 10 pounds 4.3 ounces. Results of the available survey data support the finding that Pine Flat Reservoir supports a diverse recreational fishery that is comparable to other reservoir fisheries within the Central Valley.

7.0 PUBLIC EDUCATION AND OUTREACH

7.1 INTRODUCTION

As provided in Section 1(n) of the Framework Agreement, the fishery program has engaged in public awareness and education activities.

A significant measure of the success of the fishery program is active public involvement. The Public Advisory Group (PAG) has been actively meeting on a monthly basis and engaging the TSC in discussions regarding the program as a whole, and the 5-Year Plan in particular, since adoption of the Framework Agreement. In order to encourage the PAG's continued involvement and effectiveness, the TSC has consistently recommended continued funding of PAG activities. Some activities that have been identified by the PAG for funding include: (i) intra-group communication and meeting announcements, (ii) newsletter to public at large, (iii) internet web-site, (iv) manufacture and placement of fishing regulation and educational signs, (v) Kings River Field Day, and (vi) River Keeper.

The PAG public education effort for the year consisted of (i) developing a web site, (ii) intra-group communications, and (iii) production and installation of educational signs along the lower river. Proposed changes to recreational angling regulations on the lower river designed to protect the fishery resource were also a focus of PAG activities during 2002-2003. These activities are briefly discussed below.

7.2. ANGLING REGULATION CHANGES

Rainbow trout are present in the lower Kings River in relatively low numbers. This has been documented by snorkel and electrofishing surveys between 1983 and 2003 (Section 6.2.1.1.). In an effort to protect trout that seem to have adapted to the physical conditions of the river (temperature and flow cycle) the TSC determined that changes in angling regulations were needed to provide this protection. Angling regulations are under the authority of the California Fish and Game Commission and proposals have to follow their cycle for evaluating angling regulations. The TSC worked with members of the PAG to propose the needed changes to the Fish and Game Commission. A total of three angling regulation change proposals, which are briefly described below, were forwarded by the PAG to the Commission in 2001 for adoption. All three of the proposed changes were approved and became effective March 1, 2002. They all remain in effect today.

A. Pine Flat Dam downstream to the U.S. Army Corps of Engineers Bridge

This regulation change was written to protect the large (5-6 pound) rainbow trout spawning on a series of gravel riffles just downstream of Pine Flat Dam. The rainbow trout are spawning in the December-March period and are subjected to high angler harvest while on the redds. The proposal closed the reach of the lower river between the ACOE bridge and the dam from November 15 through the Friday prior to the last Saturday in April (the opener of the general trout season for the Sierra District).

B. Mainstem

We learned that CDFG game wardens were not writing tickets for angling violations on the lower river other than in the main channel. There was a great deal of confusion over what constituted the "mainstem" Kings River. The wardens, and apparently the courts, interpreted this as the one channel with the most flow. In the courts view the general Valley Angling Regulation (5 trout per day, ten trout in possession) applied to these side channels. Working with CDFG wardens, it was decided the best way to correct this problem was simply to eliminate the term "mainstem" from the angling regulations. This has been accomplished and now the side channels of the lower Kings River are also regulated and protected.

C. Thorburn Spawning and Rearing Channel

There is an obvious need to protect trout attracted to the Thorburn spawning and rearing channel from harvest. A new angling regulation was approved that prohibits angling in the channel and within the Kings River within in a 200-foot radius of the channel's outlet.

7.3. PUBLIC EDUCATION AND OUTREACH SIGNS

During winter 2002, the Public Advisory Group, Fly Fishers for Conservation, and Kaweah Flyfishers posted angling regulation signs along the lower Kings River (Figure 7-1). River reaches posted include the catch-and-release zone from Cobbles Weir downstream to Highway 180, the special regulation zone from the ACOE Bridge to Pine Flat Dam, and the Thorburn Channel. A large 4 x 8 foot project sign was also posted at the Thorburn Channel to inform local landowners and visitors to the Kings River (Figure 7-2) about the Fisheries Management Program habitat enhancement efforts.

Figure 7-1 - Angling regulation signed installed by members of the PAG along the lower Kings River.

Figure 7-2 – Project sign being installed by PAG members at the Thorburn Channel.

7.4 SUMMER HYDROLOGY AND TEMPERATURE REPORTS

As discussed in Section 2.4, KRWA has developed a real-time telemetry system for monitoring water temperature and streamflow at Fresno Weir. During the summer of 2003 information developed from monitoring being conducted on the lower Kings River was compiled in weekly reports and distributed by KRWA to members of the PAG and other interested parties to provide current information on environmental conditions occurring within the lower river that would affect habitat quality for trout. Weekly reports were distributed electronically and were used to inform managers and other interested parties regarding conditions currently occurring within the lower river. The water temperature and flow monitoring and reporting provided a valuable tool for disseminating real-time information. The TSC has recommended that the real-time monitoring and dissemination of weekly reports, when appropriate, be continued as part of the fishery program. In addition, the TSC recommends that information on current conditions occurring within the lower Kings River be developed in a format compatible with posting on an Internet based web page that would be accessible to the public.

7.5. WEB PAGE DEVELOPMENT

The PAG has discussed the development and operation of a web page to inform the public, fishing groups, and government agencies about the FMP. Also, the web page would present angling opportunities and information related to the Kings River. The web page has been started, but it is still under development. The web page is expected to be worked on and completed in program year 2004 – 2005.

7.6. NEWS RELEASES AND NEWSLETTERS

During the May 2002 through May 2003 period, three news releases were made by the FMP. The releases were sent to all major radio, news, and newspaper sources, legislators, local government officials, and KRCD's mailing list of over 7,000 entities. The releases include 1) the gravel placement project – release dated September 30, 2002; 2) the channel ripping and coves and jetties projects – release dated October 7, 2002; and 3) the boulder placement project – release dated October 14, 2002. Copies of the news releases are presented in Appendix G. No newsletters of "Fishery News" were issued during the May 2002 through May 2003 period.

7.7 ANGLER ACCESS IMPROVEMENT (GREENBELT PARKWAY)

In fall 2002, the Fresno Flyfishers for Conservation obtained a grant from the Fresno County Recreation and Wildlife Commission to construct a graveled, 8-10 vehicle parking lot at the Green Belt Parkway. The lot would provide a safe parking area along Piedra Road and walking access through the park to the Kings River for recreational angling. The project has not been implement due to insurance issues. In the future, the FMP will adopt and implement the project.

7.8 MISCELLANEOUS

On June 6, 2002 the TSC and staff from KRCD, KRWA, U.S. Forest Service and local landowners conducted a field workshop on the Thorburn Spawning and Rearing Channel for the "Working at a Watershed Level" training course. Approximately 200 people attended the week-long workshop held at California State University, Fresno.

Mr. Tim O'Halloran, Water Master for the KRWA and ExCom member, was awarded the Conservationist of the Year by the Fresno Fly Fishers for Conservation at their April 5, 2002 banquet. Mr. O'Halloran shared the honors with Mr. Mickey Powell, who received the same honor for his long and dedicated work to the lower Kings River fishery. Mr. Powell is past chairman of the PAG. Mr. Jeff Halstead, TSC member, was the keynote speaker at the banquet.

Figure 7-3 Mickey Powell and Tim O'Halloran at the Fresno Flyfishers for Conservation Banquet.

8.0 DEVELOPMENT OF 5-YEAR PLAN

Section 1 of the Framework Agreement includes elements addressing adaptive management (Section 1b); stream temperature monitoring (Section 1d); funding for habitat enhancement projects (Section 1f); enforcement, education, and awareness program (Section 1i); stocking program (Section 1j); development of criteria/monitoring (Section 1k); and access (Section 1p). Development of a 5-Year Plan is needed to provide guidance, prioritize activities and the allocation of expenditures, and coordinate among the parties to facilitate efficient implementation of these elements of the Framework Agreement.

A 5-Year Plan was developed during this reporting period (May 2002 to June 2003). This was the third annual modification to the 5-Year Plan since the signing of the Framework Agreement in May 28, 1999. Development of the 5-year work plan is based on a consideration of (1) specific requirements identified within the Framework Agreement; (2) results of previous fisheries and water quality monitoring; and (3) prioritization of habitat restoration activities based upon limiting factors analyses. The 5-Year Plans: (1) provide a project management structure for reviewing and prioritizing proposed habitat enhancement activities, fish stocking, and other elements of the Framework Agreement; (2) identify the objectives and methods to be used to assess the overall response of trout and other species for use in evaluating achievement of the Kings River aquatic resource goals as identified in Section 1a of the Framework Agreement; and (3) provide a framework for the experimental design and evaluation of specific enhancement activities (e.g., enhancement projects funded under the Framework Agreement, fish stocking and supplementation, pulse flows for temperature management, etc.) within the context of the overall goals and activities being implemented through the Framework Agreement. Results of monitoring and evaluation activities will serve, in part, as the basis for the adaptive management element of the Framework Agreement (Section 1b) and for identifying changes in program priorities, or the allocation of resources from one program element to another. The 5-Year Plan is a "living plan" that will be reviewed by the TSC and ExCom on an annual basis throughout the 10-year period of the agreement and revised as projects and elements of the program are implemented and as new scientific information becomes available.

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10.0 APPENDICES.

Appendix A

Tabular Summary of Daily Inflow into Pine Flat Reservoir, Daily Water Releases from Pine Flat Dam, And Daily Flow Measured at Fresno Weir October 1999 – May 2003

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs	
10/1/99	367,974	684	280		
10/2/99	368,287	672	277		
10/3/99	368,772	657	275		
10/4/99	369,155	661	178		
10/5/99	369,433	687	177		42
10/6/99	369,537	726	177		38
10/7/99	369,259	709	245		39
10/8/99	369,467	695	183		60
10/9/99	370,756	183	216		64
10/10/99	371,836	160	209		51
10/11/99	373,024	166	177		50
10/12/99	374,359	171	234		48
10/13/99	375,545	171	191		46
10/14/99	376,527	172	152		46
10/15/99	377,265	166	155		47
10/16/99	378,109	159	155		46
10/17/99	378,744	144	166		48
10/18/99	379,766	153	162		38
10/19/99	380,337	159	160		42
10/20/99	381,249	160	159		42
10/21/99	382,098	159	159		43
10/22/99	382,735	160	159		41
10/23/99	383,019	161	159		46
10/24/99	383,550	161	159		46
10/25/99	384,295	161	184		44
10/26/99	384,686	158	160		46
10/27/99	385,397	158	173		43
10/28/99	386,428	149	173		41
10/29/99	387,604	149	173		41
10/30/99	388,924	148	198		46
10/31/99	389,425	145	178		45
11/1/99	389,889	142	168		46
11/2/99	390,104	145	167		46
11/3/99	390,212	142	165		38

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
11/4/99	390,354	146	165	46
11/5/99	390,461	149	165	38
11/6/99	390,533	157	165	46
11/7/99	390,641	156	162	47
11/8/99	391,107	151	495	44
11/9/99	391,393	156	284	42
11/10/99	391,608	156	258	41
11/11/99	391,895	156	257	44
11/12/99	392,110	156	251	42
11/13/99	392,325	156	247	45
11/14/99	392,540	143	245	47
11/15/99	392,864	143	245	
11/16/99	393,079	157	246	
11/17/99	393,438	154	402	
11/18/99	393,941	153	258	
11/19/99	394,229	151	277	
11/20/99	394,481	151	265	
11/21/99	394,985	142	350	
11/22/99	395,273	134	269	
11/23/99	395,561	134	238	
11/24/99	395,813	134	211	
11/25/99	395,957	134	203	
11/26/99	396,138	134	207	
11/27/99	396,354	134	209	
11/28/99	396,607	134	190	
11/29/99	396,787	134	187	
11/30/99	396,968	134	202	
12/1/99	397,257	138	263	45
12/2/99	397,474	136	231	47
12/3/99	397,690	134	238	44
12/4/99	398,124	134	254	45
12/5/99	398,594	134	222	46
12/6/99	398,847	133	213	45
12/7/99	399,137	133	206	45
12/8/99	399,318	133	156	45
12/9/99	399,571	134	222	43
12/10/99	399,752	137	160	41
12/11/99	399,934	141	189	47
12/12/99	400,151	141	187	47
12/13/99	400,404	163	174	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
12/14/99	400,477	211	228	
12/15/99	400,550	203	173	
12/16/99	400,650	188	161	
12/17/99	400,767	184	205	
12/18/99	400,804	186	180	
12/19/99	400,985	183	181	
12/20/99	401,131	156	201	
12/21/99	401,384	134	218	46
12/22/99	401,566	134	193	42
12/23/99	401,638	132	138	46
12/24/99	401,748	134	125	40
12/25/99	401,857	153	202	49
12/26/99	402,110	154	189	55
12/27/99	402,219	148	192	48
12/28/99	402,365	144	147	41
12/29/99	402,474	147	172	44
12/30/99	402,547	152	132	38
12/31/99	402,765	154	130	46
1/1/00	402,802	212	189	45
1/2/00	402,765	253	177	
1/3/00	402,583	253	147	
1/4/00	402,583	237	191	
1/5/00	402,511	236	165	
1/6/00	402,438	237	134	
1/7/00	402,365	238	181	
1/8/00	402,256	239	160	
1/9/00	402,438	238	139	
1/10/00	402,329	234	145	
1/11/00	402,183	229	173	
1/12/00	402,110	226	202	
1/13/00	402,147	225	254	
1/14/00	402,002	238	139	
1/15/00	401,966	239	195	
1/16/00	402,110	241	382	
1/17/00	402,656	243	613	
1/18/00	406,703	226	2,865	
1/19/00	408,679	209	1,142	
1/20/00	409,266	205	582	
1/21/00	409,853	205	591	
1/22/00	410,366	210	429	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
1/23/00	411,469	225	789	
1/24/00	417,856	263	3,392	
1/25/00	424,146	322	3,839	
1/26/00	426,952	207	1,659	
1/27/00	428,865	148	1,017	
1/28/00	430,182	133	841	
1/29/00	431,311	114	682	
1/30/00	432,857	115	868	
1/31/00	434,861	125	1,175	
2/1/00	436,110	112	787	46
2/2/00	437,286	112	802	45
2/3/00	438,349	116	669	39
2/4/00	439,489	128	651	50
2/5/00	440,594	125	657	47
2/6/00	441,585	125	631	46
2/7/00	442,500	128	620	46
2/8/00	443,379	136	610	51
2/9/00	444,258	135	656	46
2/10/00	445,906	135	1,077	52
2/11/00	447,977	137	1,236	54
2/12/00	450,672	173	1,576	
2/13/00	458,647	746	4,986	
2/14/00	475,527	1,261	10,293	
2/15/00	482,686	406	3,832	
2/16/00	489,136	529	3,737	
2/17/00	494,013	494	2,851	
2/18/00	497,494	260	1,993	
2/19/00	500,134	199	1,601	
2/20/00	503,555	171	2,004	
2/21/00	507,194	289	2,098	
2/22/00	510,311	186	1,742	
2/23/00	515,790	487	3,266	
2/24/00	519,391	348	2,188	
2/25/00	522,339	227	1,646	
2/26/00	525,337	196	1,590	
2/27/00	530,815	442	3,486	
2/28/00	535,690	568	2,954	
2/29/00	544,234	347	1,875	
3/1/00	547,808	232	1,680	
3/2/00	551,095	205	1,535	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
3/3/00	554,391	181	1,660	
3/4/00	559,462	509	1,974	
3/5/00	564,298	616	2,167	
3/6/00	568,287	370	1,732	
3/7/00	572,813	407	2,122	
3/8/00	576,745	329	1,746	
3/9/00	580,340	267	1,616	
3/10/00	583,858	206	1,317	
3/11/00	587,740	220	1,997	
3/12/00	591,060	234	1,694	
3/13/00	594,967	304	1,820	
3/14/00	598,799	409	2,124	
3/15/00	602,544	495	2,222	
3/16/00	606,141	577	2,234	
3/17/00	609,200	628	2,357	
3/18/00	612,627	644	2,497	
3/19/00	616,517	649	2,409	
3/20/00	619,604	683	1,935	
3/21/00	622,423	740	2,003	
3/22/00	625,068	811	1,899	
3/23/00	628,038	857	1,968	
3/24/00	630,512	943	1,993	
3/25/00	633,037	1,030	2,160	
3/26/00	635,659	1,148	2,365	
3/27/00	638,193	1,255	2,435	
3/28/00	640,364	1,258	2,331	
3/29/00	642,863	1,320	2,419	
3/30/00	644,672	1,468	2,273	
3/31/00	647,318	1,088	2,269	
4/1/00	650,205	971	2,453	
4/2/00	653,612	1,060	2,971	
4/3/00	657,638	1,189	3,515	
4/4/00	661,629	1,287	3,830	
4/5/00	665,871	1,386	4,024	
4/6/00	670,220	1,329	4,126	
4/7/00	674,490	1,616	4,377	
4/8/00	677,297	2,288	4,277	
4/9/00	679,538	2,279	3,999	
4/10/00	681,973	2,335	4,205	
4/11/00	684,270	2,292	4,474	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
4/12/00	687,723	2,320	5,304	
4/13/00	690,848	2,256	4,520	
4/14/00	692,534	2,206	2,437	
4/15/00	694,030	2,142	2,921	
4/16/00	697,122	1,709	3,974	
4/17/00	701,435	1,120	3,805	
4/18/00	704,594	1,162	2,715	
4/19/00	707,663	1,159	3,092	
4/20/00	711,032	1,114	3,360	
4/21/00	714,411	1,086	3,256	
4/22/00	717,748	1,275	3,365	
4/23/00	721,095	1,650	4,024	
4/24/00	725,092	1,698	4,455	
4/25/00	730,689	1,733	4,396	
4/26/00	737,556	1,827	7,935	
4/27/00	745,813	1,886	7,126	
4/28/00	752,758	1,853	6,391	
4/29/00	759,485	2,050	6,846	
4/30/00	766,450	2,892	8,091	
5/1/00	773,910	3,151	8,937	
5/2/00	781,928	3,262	9,884	
5/3/00	790,716	3,385	10,403	
5/4/00	799,143	3,563	9,432	
5/5/00	807,096	3,560	9,604	
5/6/00	815,991	3,518	10,314	
5/7/00	825,261	3,536	9,845	
5/8/00	834,379	3,630	11,449	
5/9/00	842,583	3,754	9,865	
5/10/00	847,216	3,888	7,400	
5/11/00	849,429	3,864	5,735	
5/12/00	850,673	3,967	5,535	
5/13/00	852,025	4,012	5,506	
5/14/00	852,513	4,032	4,739	
5/15/00	853,109	4,057	5,040	
5/16/00	853,055	4,003	4,377	
5/17/00	853,379	4,057	4,782	
5/18/00	854,519	4,267	6,057	
5/19/00	857,992	4,376	8,045	
5/20/00	863,984	4,425	9,874	
5/21/00	871,643	4,622	11,330	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
5/22/00	881,494	4,759	12,484	
5/23/00	893,970	4,856	13,622	
5/24/00	904,193	4,886	11,769	
5/25/00	912,735	4,782	10,765	
5/26/00	922,630	4,589	11,771	
5/27/00	934,302	4,584	12,405	
5/28/00	943,243	4,808	10,883	
5/29/00	949,866	4,978	9,618	
5/30/00	954,374	5,233	8,540	
5/31/00	955,244	6,397	7,779	
6/1/00	955,070	6,619	7,397	
6/2/00	954,664	6,703	7,376	
6/3/00	955,070	6,670	7,828	
6/4/00	955,822	6,706	7,663	
6/5/00	955,359	6,722	6,712	
6/6/00	954,780	6,747	6,679	
6/7/00	955,012	5,797	6,544	
6/8/00	953,854	5,622	4,879	
6/9/00	951,195	5,655	4,131	
6/10/00	947,906	5,721	4,190	
6/11/00	945,084	5,754	4,401	
6/12/00	942,610	5,819	4,697	
6/13/00	942,610	6,069	5,698	
6/14/00	943,703	6,280	5,995	
6/15/00	944,220	6,313	6,530	
6/16/00	943,473	6,280	5,890	
6/17/00	941,692	6,287	5,296	
6/18/00	938,938	6,149	4,683	
6/19/00	934,989	6,157	3,920	
6/20/00	930,421	6,258	3,729	
6/21/00	925,015	6,395	3,374	
6/22/00	918,834	6,455	2,979	
6/23/00	912,285	6,491	2,703	
6/24/00	905,426	6,554	3,069	
6/25/00	898,430	6,497	2,471	
6/26/00	890,743	6,559	2,190	
6/27/00	882,710	6,777	2,339	
6/28/00	874,773	6,944	2,502	
6/29/00	866,824	6,902	2,346	
6/30/00	859,080	6,762	2,167	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
7/1/00	850,835	6,691	1,808	
7/2/00	842,207	6,684	1,597	
7/3/00	833,469	6,714	1,563	
7/4/00	824,146	6,635	1,267	
7/5/00	814,989	6,517	1,249	
7/6/00	805,365	6,514	1,110	
7/7/00	795,965	6,487	1,084	
7/8/00	786,625	6,400	1,053	
7/9/00	777,450	6,404	1,041	
7/10/00	767,776	6,549	1,003	
7/11/00	758,066	6,597	1,008	
7/12/00	748,225	6,603	1,082	
7/13/00	738,853	6,523	1,149	
7/14/00	729,449	6,470	1,076	
7/15/00	719,618	6,395	903	
7/16/00	710,153	6,411	1,125	
7/17/00	700,465	6,411	932	
7/18/00	690,753	6,355	814	
7/19/00	681,018	6,322	840	
7/20/00	670,978	6,424	784	
7/21/00	660,924	6,419	602	
7/22/00	650,672	6,453	575	
7/23/00	640,226	6,484	669	
7/24/00	629,733	6,539	571	
7/25/00	619,012	6,613	706	
7/26/00	608,300	6,602	617	
7/27/00	597,505	6,563	643	
7/28/00	586,857	6,565	518	
7/29/00	576,307	6,387	545	
7/30/00	566,074	6,276	569	
7/31/00	556,193	6,222	653	
8/1/00	546,317	6,246	725	
8/2/00	535,943	6,439	641	
8/3/00	525,963	6,430	849	
8/4/00	518,438	5,125	731	
8/5/00	510,763	5,075	661	
8/6/00	503,514	4,891	717	
8/7/00	496,359	4,829	700	
8/8/00	489,337	4,692	676	
8/9/00	482,566	4,545	646	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
8/10/00	476,161	4,429	666	
8/11/00	469,603	4,345	497	
8/12/00	462,971	4,348	477	
8/13/00	456,898	4,149	611	
8/14/00	451,211	3,984	532	
8/15/00	445,982	3,668	491	
8/16/00	441,013	3,394	299	
8/17/00	435,883	3,443	279	
8/18/00	430,671	3,457	300	
8/19/00	425,304	3,534	290	
8/20/00	420,121	3,446	285	
8/21/00	414,860	3,461	250	
8/22/00	410,330	3,035	275	
8/23/00	406,703	2,450	275	
8/24/00	403,456	2,329	273	
8/25/00	400,658	2,133	271	
8/26/00	398,124	2,102	262	
8/27/00	395,525	2,088	261	
8/28/00	392,900	2,087	268	
8/29/00	390,999	1,687	289	
8/30/00	390,319	1,122	330	
8/31/00	389,997	845	419	
9/1/00	390,053	732	289	
9/2/00	389,818	680	413	
9/3/00	389,425	775	419	
9/4/00	389,318	816	389	
9/5/00	389,175	833	371	
9/6/00	388,853	899	359	
9/7/00	388,032	1,022	350	
9/8/00	386,962	1,053	320	
9/9/00	385,894	1,037	296	
9/10/00	385,076	1,023	288	
9/11/00	384,153	1,015	239	
9/12/00	383,266	1,060	276	
9/13/00	382,664	1,071	314	
9/14/00	381,956	946	241	
9/15/00	381,143	972	241	
9/16/00	379,977	1,094	239	
9/17/00	379,025	1,094	237	
9/18/00	378,074	1,107	252	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
9/19/00	377,020	1,102	254	
9/20/00	375,790	1,089	171	
9/21/00	374,389	1,097	193	
9/22/00	372,535	1,141	221	
9/23/00	370,547	1,151	221	
9/24/00	369,085	1,149	202	
9/25/00	367,627	1,189	202	
9/26/00	366,033	1,283	201	
9/27/00	363,718	1,285	199	
9/28/00	362,168	1,121	201	
9/29/00	360,449	1,021	199	
10/1/00	358,528	1,183	187	
10/2/00	356,819	1,279	149	
10/3/00	354,670	1,296	184	
10/4/00	352,767	1,326	157	
10/5/00	350,767	1,342	157	
10/6/00	348,604	1,384	157	
10/7/00	346,212	1,418	156	
10/8/00	343,629	1,419	156	
10/9/00	341,422	1,398	156	
10/10/00	339,722	1,201	220	
10/11/00	338,492	948	291	50
10/12/00	337,595	823	274	52
10/13/00	336,766	726	280	48
10/14/00	335,971	645	275	46
10/15/00	336,137	216	273	60
10/16/00	336,468	127	270	53
10/17/00	336,866	132	268	55
10/18/00	337,098	132	262	56
10/19/00	337,396	131	256	55
10/20/00	337,662	132	255	50
10/21/00	338,060	132	251	54
10/22/00	338,193	132	250	54
10/23/00	338,326	132	254	52
10/24/00	338,525	132	258	52
10/25/00	338,691	132	257	52
10/26/00	338,957	132	262	53
10/27/00	339,290	129	304	57
10/28/00	339,589	128	303	59
10/29/00	340,722	120	1,020	58

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
10/30/00	341,823	115	816	56
10/31/00	343,194	116	462	55
11/1/00	344,266	116	401	56
11/2/00	345,335	116	390	56
11/3/00	346,751	115	388	57
11/4/00	347,660	109	376	53
11/5/00	348,503	111	357	53
11/6/00	349,515	113	354	52
11/7/00	350,563	111	352	50
11/8/00	351,444	121	351	55
11/9/00	352,495	122	405	56
11/10/00	353,684	124	435	61
11/11/00	354,704	126	376	69
11/12/00	355,624	131	385	64
11/13/00	356,785	136	314	69
11/14/00	357,913	132	317	69
11/15/00	359,282	133	301	69
11/16/00	360,723	135	289	70
11/17/00	362,202	124	268	68
11/18/00	363,891	118	249	59
11/19/00	365,583	120	251	64
11/20/00	367,072	120	247	65
11/21/00	368,320	120	242	66
11/22/00	369,676	120	244	67
11/23/00	370,826	118	242	67
11/24/00	371,767	118	236	67
11/25/00	372,570	118	238	67
11/26/00	373,304	118	237	67
11/27/00	374,493	115	237	66
11/28/00	375,685	114	238	65
11/29/00	376,879	113	233	65
11/30/00	378,109	116	233	84
12/1/00	379,378	113	227	96
12/2/00	380,225	108	228	91
12/3/00	381,108	112	218	90
12/4/00	381,779	113	211	92
12/5/00	383,161	113	211	92
12/6/00	384,331	108	210	94
12/7/00	385,681	105	209	90
12/8/00	386,749	108	217	87

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
12/9/00	388,282	116	220	94
12/10/00	389,282	117	218	100
12/11/00	391,464	117	213	86
12/12/00	392,792	120	219	92
12/13/00	394,589	118	222	102
12/14/00	396,427	113	216	95
12/15/00	398,413	110	220	95
12/16/00	399,101	108	219	91
12/17/00	399,825	110	219	91
12/18/00	400,913	111	252	92
12/19/00	402,002	113	247	92
12/20/00	402,875	111	245	94
12/21/00	403,456	110	244	95
12/22/00	404,075	103	236	94
12/23/00	404,513	101	233	87
12/24/00	405,096	106	233	86
12/25/00	405,789	106	231	87
12/26/00	406,374	108	225	87
12/27/00	407,069	111	220	86
12/28/00	407,617	112	218	87
12/29/00	408,187	110	220	88
12/30/00	408,496	110	209	90
12/31/00	408,826	112	213	91
1/1/01	409,119	113	210	91
1/2/01	409,596	113	211	91
1/3/01	410,037	111	210	90
1/4/01	410,403	108	213	91
1/5/01	410,844	107	214	91
1/6/01	410,992	107	212	91
1/7/01	411,102	108	177	91
1/8/01	411,396	107	363	94
1/9/01	411,580	105	244	91
1/10/01	412,352	108	704	91
1/11/01	413,347	147	739	137
1/12/01	414,010	118	597	111
1/13/01	414,454	125	469	88
1/14/01	414,749	126	334	90
1/15/01	415,155	128	300	94
1/16/01	415,562	132	286	91
1/17/01	416,005	135	297	90

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
1/18/01	416,338	136	244	87
1/19/01	416,893	136	262	87
1/20/01	417,375	134	258	87
1/21/01	417,782	135	265	86
1/22/01	418,079	135	261	87
1/23/01	418,450	141	278	77
1/24/01	419,563	145	768	91
1/25/01	420,567	126	573	84
1/26/01	421,572	121	550	75
1/27/01	422,354	117	391	68
1/28/01	422,988	123	364	62
1/29/01	423,697	132	414	65
1/30/01	424,332	139	442	65
1/31/01	425,154	137	434	66
2/1/01	425,716	136	327	66
2/2/01	426,207	135	377	63
2/3/01	426,615	136	350	62
2/4/01	427,289	126	558	62
2/5/01	428,453	126	604	62
2/6/01	429,430	123	514	62
2/7/01	430,370	123	574	62
2/8/01	431,198	126	531	56
2/9/01	432,292	115	521	69
2/10/01	433,612	112	694	72
2/11/01	435,239	220	1,187	160
2/12/01	436,868	174	745	135
2/13/01	438,387	117	662	77
2/14/01	439,680	106	634	76
2/15/01	440,632	106	570	67
2/16/01	441,470	109	597	67
2/17/01	442,271	112	454	69
2/18/01	443,149	116	553	70
2/19/01	444,182	121	687	70
2/20/01	445,560	122	859	73
2/21/01	446,749	116	739	69
2/22/01	448,093	121	678	67
2/23/01	449,323	123	565	66
2/24/01	450,864	129	1,040	77
2/25/01	452,137	151	844	101
2/26/01	453,141	227	760	170

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
2/27/01	453,876	408	737	
2/28/01	454,611	358	822	
3/1/01	455,154	421	775	
3/2/01	455,348	508	659	
3/3/01	455,464	463	436	
3/4/01	456,472	416	1,031	
3/5/01	458,453	304	1,306	
3/6/01	459,931	320	953	
3/7/01	461,062	341	873	
3/8/01	461,724	430	727	
3/9/01	462,779	434	1,107	
3/10/01	463,834	354	917	
3/11/01	464,930	302	884	
3/12/01	465,792	266	753	
3/13/01	466,734	301	876	
3/14/01	467,676	294	841	
3/15/01	468,973	288	941	
3/16/01	470,194	302	1,034	
3/17/01	471,218	303	1,041	
3/18/01	472,600	289	1,231	
3/19/01	475,052	292	1,667	
3/20/01	477,947	329	2,103	
3/21/01	480,772	460	2,243	
3/22/01	483,086	550	2,192	
3/23/01	485,806	491	2,351	
3/24/01	489,096	427	2,270	
3/25/01	491,914	412	2,399	
3/26/01	494,862	412	2,386	
3/27/01	498,386	414	2,720	
3/28/01	502,169	439	2,969	
3/29/01	506,948	480	3,548	
3/30/01	511,832	488	3,670	
3/31/01	517,113	412	4,098	
4/1/01	522,921	385	4,433	
4/2/01	528,428	388	3,988	
4/3/01	532,872	368	3,257	
4/4/01	536,365	359	2,556	
4/5/01	539,319	384	2,163	
4/6/01	541,690	405	1,879	
4/7/01	545,211	409	2,434	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
4/8/01	547,808	329	1,990	
4/9/01	550,325	307	1,759	
4/10/01	552,548	298	1,546	
4/11/01	554,734	256	1,931	
4/12/01	556,751	255	1,428	
4/13/01	558,859	255	1,467	
4/14/01	560,842	319	1,542	
4/15/01	562,785	402	1,767	
4/16/01	565,208	438	1,914	
4/17/01	568,113	469	2,407	
4/18/01	571,200	462	2,539	
4/19/01	574,865	385	2,655	
4/20/01	578,935	285	2,740	
4/21/01	582,888	254	2,491	
4/22/01	586,503	251	2,363	
4/23/01	590,041	251	2,605	
4/24/01	594,612	375	3,296	
4/25/01	600,228	472	4,536	
4/26/01	607,130	577	5,364	
4/27/01	614,435	753	6,010	
4/28/01	622,378	919	6,238	
4/29/01	629,687	987	6,002	
4/30/01	637,271	1,214	6,622	
5/1/01	646,018	1,492	8,013	
5/2/01	655,716	1,564	8,283	
5/3/01	662,994	1,599	6,603	
5/4/01	667,901	1,658	5,398	
5/5/01	673,207	1,698	5,952	
5/6/01	680,015	1,707	7,024	
5/7/01	689,261	1,711	8,719	
5/8/01	699,931	1,745	9,568	
5/9/01	710,935	1,805	9,755	
5/10/01	721,046	2,102	9,686	
5/11/01	731,731	2,133	9,846	
5/12/01	741,853	2,145	9,209	
5/13/01	748,325	2,190	7,586	
5/14/01	753,111	2,218	5,352	
5/15/01	758,623	2,306	7,046	
5/16/01	766,755	2,391	8,496	
5/17/01	774,730	2,832	8,687	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
5/18/01	781,978	2,844	8,084	
5/19/01	787,659	2,557	6,940	
5/20/01	793,571	2,568	7,190	
5/21/01	800,187	2,627	7,547	
5/22/01	807,254	2,533	7,530	
5/23/01	814,250	2,407	7,244	
5/24/01	820,911	2,357	6,842	
5/25/01	827,549	2,315	7,049	
5/26/01	834,057	2,274	6,284	
5/27/01	839,467	2,262	5,771	
5/28/01	843,498	2,271	5,006	
5/29/01	846,892	2,290	4,722	
5/30/01	850,781	2,187	4,468	
5/31/01	855,169	2,092	4,713	
6/1/01	859,080	2,134	4,336	
6/2/01	861,040	2,770	4,101	
6/3/01	856,852	5,423	3,153	
6/4/01	852,025	5,079	2,622	
6/5/01	847,540	4,909	2,452	
6/6/01	842,423	5,387	2,447	
6/7/01	835,983	6,020	2,184	
6/8/01	828,827	6,303	2,402	
6/9/01	820,964	6,533	2,011	
6/10/01	812,300	6,829	1,959	
6/11/01	803,219	6,895	1,712	
6/12/01	793,779	7,015	1,656	
6/13/01	784,093	6,996	1,570	
6/14/01	774,064	7,013	1,361	
6/15/01	763,802	7,032	1,243	
6/16/01	753,263	7,108	1,217	
6/17/01	742,654	7,051	1,158	
6/18/01	732,229	6,850	1,482	
6/19/01	722,525	6,508	1,405	
6/20/01	713,431	6,443	1,300	
6/21/01	704,642	6,311	1,225	
6/22/01	695,624	6,370	1,230	
6/23/01	686,571	6,381	1,130	
6/24/01	677,440	6,320	1,114	
6/25/01	668,091	6,273	952	
6/26/01	659,045	6,182	900	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
6/27/01	649,553	6,319	900	
6/28/01	639,810	6,438	854	
6/29/01	629,916	6,400	803	
6/30/01	619,285	6,460	663	
7/1/01	608,165	6,708	771	
7/2/01	597,327	6,792	710	
7/3/01	586,591	6,859	800	
7/4/01	575,257	7,033	898	
7/5/01	564,298	7,043	975	
7/6/01	553,919	6,971	1,194	
7/7/01	544,192	6,923	1,555	
7/8/01	535,143	6,552	1,780	
7/9/01	525,880	6,746	1,628	
7/10/01	515,707	6,892	1,321	
7/11/01	508,463	5,185	1,073	
7/12/01	501,598	4,965	1,005	
7/13/01	495,105	4,598	861	
7/14/01	488,332	4,477	700	
7/15/01	481,130	4,479	695	
7/16/01	474,695	4,319	567	
7/17/01	468,227	4,304	528	
7/18/01	461,724	4,301	537	
7/19/01	455,192	4,246	400	
7/20/01	448,747	4,109	439	
7/21/01	442,043	4,070	364	
7/22/01	435,315	4,082	397	
7/23/01	428,603	4,162	360	
7/24/01	421,609	4,409	386	
7/25/01	414,491	4,441	346	
7/26/01	406,666	4,882	324	
7/27/01	398,015	4,983	312	
7/28/01	389,389	4,836	298	
7/29/01	380,613	4,880	288	
7/30/01	372,255	4,766	281	
7/31/01	366,241	3,625	234	
8/1/01	361,445	2,992	259	
8/2/01	356,648	3,007	252	
8/3/01	351,545	3,138	249	
8/4/01	345,944	3,168	244	
8/5/01	340,122	3,183	239	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
8/6/01	335,079	3,094	259	
8/7/01	330,206	3,006	254	
8/8/01	325,891	2,975	247	
8/9/01	322,513	2,173	251	
8/10/01	319,637	2,007	255	
8/11/01	316,453	2,005	252	
8/12/01	313,063	2,045	247	
8/13/01	310,262	1,962	240	
8/14/01	307,476	1,848	236	
8/15/01	304,796	1,809	244	
8/16/01	302,787	1,477	244	
8/17/01	300,910	1,338	239	
8/18/01	298,416	1,617	234	
8/19/01	295,748	1,694	230	
8/20/01	293,555	1,579	152	
8/21/01	291,708	1,390	152	
8/22/01	289,867	1,362	126	
8/23/01	288,246	1,315	125	
8/24/01	286,600	1,318	121	
8/25/01	284,776	1,263	121	
8/26/01	282,807	1,311	116	
8/27/01	281,207	1,232	103	
8/28/01	279,883	1,153	101	
8/29/01	278,741	1,003	101	
8/30/01	278,472	731	100	
8/31/01	278,142	740	101	
9/1/01	277,393	751	100	
9/2/01	276,675	731	99	
9/3/01	276,108	658	177	
9/4/01	275,988	652	186	
9/5/01	275,929	650	204	
9/6/01	275,749	666	185	
9/7/01	275,570	691	175	
9/8/01	275,213	658	170	
9/9/01	274,617	669	162	
9/10/01	274,290	658	160	
9/11/01	274,081	692	160	
9/12/01	273,517	690	158	
9/13/01	273,963	327	155	
9/14/01	274,230	298	150	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
9/15/01	274,141	315	147	
9/16/01	274,230	333	143	
9/17/01	274,558	326	134	
9/18/01	274,945	320	133	
9/19/01	275,183	320	178	
9/20/01	275,452	318	183	
9/21/01	275,720	315	186	
9/22/01	275,899	327	195	
9/23/01	275,630	326	182	
9/24/01	275,660	323	145	
9/25/01	275,779	317	173	
9/26/01	275,869	317	140	
9/27/01	275,839	315	129	
9/28/01	276,018	296	144	
9/29/01	276,018	297	125	
9/30/01	276,048	277	125	
10/1/01	276,615	154	156	83
10/2/01	277,303	157	129	84
10/3/01	277,992	155	139	82
10/4/01	278,442	146	124	78
10/5/01	278,831	139	131	70
10/6/01	278,801	152	132	83
10/7/01	278,741	149	133	88
10/8/01	278,982	143	134	82
10/9/01	279,341	147	137	85
10/10/01	279,732	147	137	87
10/11/01	280,183	147	135	87
10/12/01	280,484	147	133	82
10/13/01	280,454	146	133	85
10/14/01	280,726	143	121	87
10/15/01	281,057	140	117	82
10/16/01	281,268	141	113	78
10/17/01	281,539	147	113	83
10/18/01	281,871	147	113	84
10/19/01	282,293	147	114	82
10/20/01	282,444	144	111	85
10/21/01	282,596	140	113	84
10/22/01	283,079	139	114	83
10/23/01	283,170	141	115	82
10/24/01	283,594	141	113	83

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
10/25/01	284,048	141	112	83
10/26/01	284,473	141	114	83
10/27/01	284,594	135	113	93
10/28/01	284,776	128	113	93
10/29/01	285,140	119	115	84
10/30/01	285,930	117	508	84
10/31/01	286,752	116	325	88
11/1/01	287,605	116	316	87
11/2/01	288,277	116	254	89
11/3/01	288,613	116	179	90
11/4/01	288,949	116	158	90
11/5/01	289,438	113	154	99
11/6/01	290,081	105	200	95
11/7/01	290,694	101	189	91
11/8/01	291,309	101	185	89
11/9/01	291,892	101	177	89
11/10/01	292,261	101	170	88
11/11/01	292,754	101	232	90
11/12/01	293,863	102	525	93
11/13/01	294,666	101	328	76
11/14/01	295,500	101	328	53
11/15/01	296,274	101	309	52
11/16/01	297,081	100	246	79
11/17/01	297,578	101	228	81
11/18/01	297,981	101	219	81
11/19/01	298,634	101	258	81
11/20/01	299,350	101	229	81
11/21/01	300,098	101	305	72
11/22/01	300,722	101	403	72
11/23/01	301,879	101	579	73
11/24/01	305,017	102	2,189	73
11/25/01	307,729	102	1,455	73
11/26/01	309,216	102	778	67
11/27/01	310,707	102	589	62
11/28/01	311,883	102	506	62
11/29/01	313,509	102	875	71
11/30/01	314,916	103	621	73
12/1/01	316,325	103	696	77
12/2/01	318,316	103	1,173	83
12/3/01	321,025	103	1,607	82

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
12/4/01	322,675	107	995	82
12/5/01	323,972	102	734	62
12/6/01	325,208	102	789	45
12/7/01	326,218	102	745	47
12/8/01	327,359	102	842	47
12/9/01	328,470	102	625	47
12/10/01	329,288	176	646	37
12/11/01	330,009	231	625	
12/12/01	330,665	228	583	
12/13/01	331,190	231	543	
12/14/01	331,947	235	731	
12/15/01	332,539	235	567	
12/16/01	333,066	239	553	
12/17/01	333,626	237	573	
12/18/01	334,352	171	537	45
12/19/01	335,046	119	487	48
12/20/01	336,104	117	838	48
12/21/01	337,064	122	655	45
12/22/01	338,027	125	665	52
12/23/01	338,890	123	645	46
12/24/01	339,889	118	704	48
12/25/01	340,789	105	596	55
12/26/01	341,689	102	439	50
12/27/01	342,558	105	694	57
12/28/01	343,997	103	955	59
12/29/01	352,122	461	4,744	
12/30/01	356,443	250	2,589	
12/31/01	359,796	190	2,001	
1/1/02	362,374	125	1,546	
1/2/02	364,857	107	1,391	91
1/3/02	368,494	207	2,164	
1/4/02	371,034	128	1,490	
1/5/02	373,618	113	1,190	75
1/6/02	376,142	114	1,137	69
1/7/02	377,828	120	1,074	67
1/8/02	379,449	130	1,113	67
1/9/02	381,002	133	1,063	72
1/10/02	382,558	128	1,031	71
1/11/02	384,083	126	942	70
1/12/02	385,432	125	929	73

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
1/13/0				
1/14/02	388,282	132	930	69
1/15/02	389,425	135	827	66
1/16/02	390,497	135	768	62
1/17/02	391,572	136	761	64
1/18/02	393,438	134	560	64
1/19/02	395,417	130	814	64
1/20/02	397,293	125	634	64
1/21/02	399,246	118	649	64
1/22/02	401,166	118	619	65
1/23/02	402,583	116	571	60
1/24/02	404,477	114	654	60
1/25/02	406,228	113	619	67
1/26/02	407,580	114	619	67
1/27/02	409,596	118	796	70
1/28/02	411,690	118	825	73
1/29/02	413,605	113	720	65
1/30/02	415,562	112	668	47
1/31/02	417,375	112	628	47
2/1/02	419,415	113	744	50
2/2/02	421,312	115	673	55
2/3/02	423,175	114	636	55
2/4/02	424,856	182	641	55
2/5/02	426,465	223	646	
2/6/02	427,857	224	673	
2/7/02	429,430	226	645	
2/8/02	430,483	576	746	
2/9/02	431,500	552	767	
2/10/02	432,706	478	725	
2/11/02	433,839	508	725	
2/12/02	434,861	587	762	
2/13/02	435,807	632	758	
2/14/02	436,868	674	876	
2/15/02	438,083	655	860	
2/16/02	439,071	756	832	
2/17/02	440,137	935	1,175	
2/18/02	441,317	870	902	
2/19/02	441,737	913	975	
2/20/02	441,966	956	956	
2/21/02	442,348	921	1,040	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
2/22/02	442,768	890	1,040	
2/23/02	442,959	857	1,148	
2/24/02	443,226	876	1,176	
2/25/02	443,915	926	1,204	
2/26/02	444,565	940	1,245	
2/27/02	445,330	940	1,310	
2/28/02	446,058	914	1,287	
3/1/02	446,940	900	1,295	
3/2/02	447,594	714	1,202	
3/3/02	448,362	635	1,134	
3/4/02	449,516	606	1,124	
3/5/02	450,710	586	1,106	
3/6/02	452,408	552	1,308	
3/7/02	454,960	493	1,230	
3/8/02	457,404	450	1,459	
3/9/02	458,880	455	1,102	
3/10/02	460,126	485	1,251	
3/11/02	461,685	483	1,196	
3/12/02	463,092	606	1,303	
3/13/02	464,109	892	1,495	
3/14/02	464,617	1,013	1,301	
3/15/02	464,109	1,390	1,028	
3/16/02	462,974	1,516	1,071	
3/17/02	461,646	1,515	988	
3/18/02	460,788	1,429	873	
3/19/02	460,126	1,414	983	
3/20/02	459,580	1,384	1,034	
3/21/02	459,075	1,384	1,069	
3/22/02	458,763	1,358	1,193	
3/23/02	458,569	1,347	1,420	
3/24/02	458,569	1,342	1,496	
3/25/02	458,569	1,344	1,304	
3/26/02	458,336	1,371	1,190	
3/27/02	458,064	1,406	1,216	
3/28/02	458,064	1,340	1,345	
3/29/02	458,142	1,284	1,506	
3/30/02	458,414	1,278	1,846	
3/31/02	459,192	1,271	2,143	
4/1/02	460,632	1,347	2,636	
4/2/02	462,661	1,454	2,909	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
4/3/02	465,087	1,513	3,433	
4/4/02	467,873	1,564	3,780	
4/5/02	471,061	1,633	4,006	
4/6/02	473,390	1,694	3,598	
4/7/02	475,566	1,653	3,601	
4/8/02	478,344	1,648	3,939	
4/9/02	482,008	1,690	4,408	
4/10/02	485,244	1,683	4,410	
4/11/02	489,659	1,728	5,127	
4/12/02	495,064	1,744	5,910	
4/13/02	500,662	1,743	6,293	
4/14/02	507,235	1,742	6,926	
4/15/02	515,419	1,739	7,422	
4/16/02	520,387	1,729	5,050	
4/17/02	524,003	1,780	4,294	
4/18/02	526,255	1,798	3,498	
4/19/02	527,759	1,684	2,920	
4/20/02	528,553	1,675	2,547	
4/21/02	528,972	1,671	2,426	
4/22/02	529,726	1,665	2,538	
4/23/02	531,109	1,653	3,016	
4/24/02	533,544	1,637	3,684	
4/25/02	536,323	1,630	4,034	
4/26/02	540,461	1,606	4,696	
4/27/02	543,385	1,536	3,832	
4/28/02	545,637	1,482	3,198	
4/29/02	548,021	1,466	3,011	
4/30/02	549,898	1,420	2,670	
5/1/02	551,309	1,422	2,409	
5/2/02	552,292	1,737	2,463	
5/3/02	553,063	1,879	2,684	
5/4/02	553,833	1,996	3,203	
5/5/02	554,819	2,070	3,667	
5/6/02	557,826	2,141	4,565	
5/7/02	561,748	2,305	5,181	
5/8/02	565,684	2,378	5,336	
5/9/02	569,460	2,349	5,775	
5/10/02	573,205	2,296	5,225	
5/11/02	575,214	2,448	4,559	
5/12/02	577,008	2,448	4,626	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
5/13/02	578,322	3,201	5,071	
5/14/02	580,734	3,394	6,048	
5/15/02	583,814	3,396	6,364	
5/16/02	587,696	3,420	6,837	
5/17/02	592,613	3,624	7,858	
5/18/02	597,416	3,813	8,144	
5/19/02	601,972	3,861	7,790	
5/20/02	605,468	3,769	6,652	
5/21/02	606,995	3,756	5,479	
5/22/02	606,770	3,790	4,473	
5/23/02	606,141	3,817	4,202	
5/24/02	605,288	3,903	4,199	
5/25/02	604,032	4,086	4,511	
5/26/02	603,539	4,177	5,176	
5/27/02	604,346	4,237	5,877	
5/28/02	605,872	4,350	6,218	
5/29/02	608,479	4,232	6,808	
5/30/02	612,040	4,199	7,316	
5/31/02	616,427	4,198	7,680	
6/1/02	619,921	4,188	7,376	
6/2/02	621,695	4,186	6,122	
6/3/02	619,376	6,225	5,711	
6/4/02	617,289	5,836	5,522	
6/5/02	616,789	5,996	6,448	
6/6/02	614,842	6,154	5,897	
6/7/02	613,666	6,005	6,240	
6/8/02	612,085	5,678	5,362	
6/9/02	607,939	6,050	4,369	
6/10/02	602,867	6,258	3,753	
6/11/02	597,015	6,296	3,427	
6/12/02	590,749	6,377	3,320	
6/13/02	584,783	6,423	3,512	
6/14/02	579,067	6,402	3,609	
6/15/02	572,943	6,328	3,577	
6/16/02	566,594	6,255	3,348	
6/17/02	560,108	6,095	3,045	
6/18/02	554,048	6,091	3,064	
6/19/02	548,532	6,027	3,135	
6/20/02	542,961	6,001	3,069	
6/21/02	537,081	6,044	3,043	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
6/22/02	530,145	6,105	2,549	
6/23/02	522,381	6,165	2,098	
6/24/02	515,088	6,022	2,049	
6/25/02	507,398	6,178	2,015	
6/26/02	499,279	6,305	2,078	
6/27/02	490,625	6,396	1,852	
6/28/02	482,446	6,419	2,068	
6/29/02	473,627	6,524	1,827	
6/30/02	465,166	6,479	2,023	
7/1/02	456,743	6,451	1,761	
7/2/02	448,285	6,477	1,731	
7/3/02	439,566	6,563	1,593	
7/4/02	430,671	6,580	1,760	
7/5/02	420,753	6,578	966	
7/6/02	411,396	6,674	1,296	
7/7/02	401,384	6,713	1,119	
7/8/02	391,608	6,595	1,087	
7/9/02	381,992	6,666	1,160	
7/10/02	371,383	6,916	939	
7/11/02	360,380	7,102	888	
7/12/02	349,347	7,122	972	
7/13/02	337,596	7,265	885	
7/14/02	326,087	7,119	841	
7/15/02	318,027	5,427	839	
7/16/02	310,453	5,120	812	
7/17/02	302,881	5,139	659	
7/18/02	295,438	5,012	736	
7/19/02	288,033	4,943	670	
7/20/02	280,454	4,825	617	
7/21/02	272,567	4,894	534	
7/22/02	264,828	4,812	517	
7/23/02	257,253	4,703	496	
7/24/02	250,440	4,573	465	
7/25/02	243,237	4,574	454	
7/26/02	236,091	4,553	444	
7/27/02	228,625	4,579	434	
7/28/02	221,179	4,561	419	
7/29/02	213,707	4,572	407	
7/30/02	206,807	4,443	397	
7/31/02	199,976	4,306	382	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
8/1/02	193,464	4,237	294	
8/2/02	186,726	4,309	290	
8/3/02	179,734	4,246	285	
8/4/02	172,951	4,128	277	
8/5/02	166,490	4,102	265	
8/6/02	160,404	3,719	255	
8/7/02	155,427	3,325	247	
8/8/02	151,901	2,581	237	
8/9/02	148,934	2,322	233	
8/10/02	145,806	2,280	220	
8/11/02	142,713	2,212	210	
8/12/02	139,988	2,164	204	
8/13/02	137,146	2,201	200	
8/14/02	133,601	2,416	195	
8/15/02	130,567	2,253	190	
8/16/02	128,066	1,898	189	
8/17/02	125,551	1,805	187	
8/18/02	122,965	1,739	182	
8/19/02	120,831	1,643	179	
8/20/02	118,928	1,570	177	
8/21/02	118,030	1,298	174	
8/22/02	117,782	1,030	172	
8/23/02	118,201	840	169	
8/24/02	118,526	844	166	
8/25/02	118,794	751	163	
8/26/02	119,119	659	157	
8/27/02	119,618	683	153	
8/28/02	119,964	633	150	
8/29/02	120,504	500	146	
8/30/02	121,257	409	146	
8/31/02	121,818	360	146	
9/1/02	122,471	341	166	
9/2/02	123,004	323	162	
9/3/02	123,648	287	158	
9/4/02	124,216	401	156	
9/5/02	124,784	335	159	
9/6/02	124,883	325	169	
9/7/02	125,177	308	174	
9/8/02	125,335	299	173	
9/9/02	125,670	300	175	

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Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
9/10/02	126,044	302	167	
9/11/02	126,439	311	161	
9/12/02	126,934	313	163	
9/13/02	127,529	313	161	
9/14/02	127,848	313	158	
9/15/02	127,907	313	153	
9/16/02	128,385	257	150	
9/17/02	128,884	218	150	
9/18/02	129,423	208	153	
9/19/02	130,105	208	150	
9/20/02	130,869	208	149	
9/21/02	131,292	209	146	
9/22/02	131,756	210	144	
9/23/02	132,201	210	144	
9/24/02	132,748	211	141	
9/25/02	133,337	210	139	
9/26/02	133,785	214	139	
9/27/02	133,744	220	137	
9/28/02	133,581	222	139	
9/29/02	133,418	222	147	
9/30/02	133,296	197	156	
10/1/02	133,215	182	134	
10/2/02	133,174	176	140	
10/3/02	133,296	170	151	
10/4/02	133,296	166	151	
10/5/02	133,622	166	149	
10/6/02	134,172	165	146	
10/7/02	134,764	162	143	
10/8/02	135,296	159	139	
10/9/02	135,296	159	136	
10/10/02	135,255	155	134	
10/11/02	135,296	152	136	
10/12/02	135,521	149	138	
10/13/02	135,768	149	138	
10/14/02	136,034	149	136	
10/15/02	136,240	149	134	
10/16/02	136,240	149	132	
10/17/02	136,219	149	132	
10/18/02	136,199	149	132	
10/19/02	136,178	149	132	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
10/20/02	136,364	149	132	
10/21/02	136,858	142	132	
10/22/02	137,725	134	132	
10/23/02	138,512	134	132	
10/24/02	139,134	134	132	
10/25/02	139,863	134	134	
10/26/02	140,259	134	134	
10/27/02	140,886	133	134	
10/28/02	141,578	131	135	46
10/29/02	142,292	124	134	43
10/30/02	143,029	125	134	43
10/31/02	143,684	125	134	45
11/1/02	144,298	125	135	69
11/2/02	144,488	125	135	82
11/3/02	144,849	125	135	92
11/4/02	145,444	124	134	89
11/5/02	145,849	122	133	88
11/6/02	146,169	120	133	89
11/7/02	147,066	112	370	105
11/8/02	165,054	108	10,969	116
11/9/02	181,761	119	9,395	110
11/10/02	186,556	104	2,555	93
11/11/02	189,749	106	1,573	97
11/12/02	191,688	102	1,205	93
11/13/02	193,340	103	1,025	98
11/14/02	194,902	103	919	94
11/15/02	196,544	103	875	94
11/16/02	198,043	102	661	92
11/17/02	199,850	102	644	96
11/18/02	201,742	103	619	94
11/19/02	203,542	104	593	96
11/20/02	205,043	104	657	96
11/21/02	206,474	105	642	96
11/22/02	208,039	105	683	94
11/23/02	209,352	102	578	97
11/24/02	210,798	102	592	98
11/25/02	212,172	102	661	96
11/26/02	213,394	102	525	96
11/28/02	215,301	103	395	96
11/29/02	216,244	103	388	96

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
11/30/02	217,347	103	381	97
12/1/02	218,427	104	419	98
12/2/02	219,457	105	412	95
12/3/02	220,489	103	396	94
12/4/02	221,577	105	378	82
12/5/02	222,695	103	374	75
12/6/02	223,816	103	373	74
12/7/02	224,698	103	365	75
12/8/02	225,663	104	354	77
12/9/02	226,764	104	339	75
12/10/02	227,923	102	341	80
12/11/02	229,030	103	332	60
12/12/02	230,276	103	320	57
12/13/02	231,389	104	323	62
12/14/02	232,260	104	356	64
12/15/02	233,297	102	597	63
12/16/02	235,295	107	1,109	75
12/17/02	237,687	112	1,200	78
12/18/02	239,512	111	825	71
12/19/02	241,370	106	826	66
12/20/02	243,600	143	1,088	105
12/21/02	245,336	103	831	71
12/22/02	246,965	105	741	68
12/23/02	248,601	103	641	64
12/24/02	250,072	104	613	68
12/25/02	251,405	104	582	68
12/26/02	252,770	101	508	68
12/27/02	254,283	101	587	70
12/28/02	255,914	103	830	78
12/29/02	257,840	111	929	98
12/30/02	259,570	103	934	78
12/31/02	261,684	108	1,159	84
1/1/03	263,545	104	989	81
1/2/03	265,179	105	913	77
1/3/03	267,082	106	976	75
1/4/03	269,169	106	1,162	81
1/5/03	270,910	105	830	83
1/6/03	272,686	105	1,138	81
1/7/03	273,814	104	863	79
1/8/03	275,213	103	877	79

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
1/9/03	276,765	105	860	74
1/10/03	278,621	113	1,092	77
1/11/03	279,943	113	908	67
1/12/03	281,268	114	756	67
1/13/03	282,656	116	835	69
1/14/03	283,776	129	772	66
1/15/03	284,958	129	736	67
1/16/03	286,052	132	720	63
1/17/03	287,117	140	810	64
1/18/03	288,185	140	775	64
1/19/03	289,500	139	805	63
1/20/03	290,694	140	773	65
1/21/03	291,954	139	830	65
1/22/03	293,031	140	890	66
1/23/03	294,234	137	740	65
1/24/03	295,408	143	836	63
1/25/03	296,399	142	699	66
1/26/03	297,732	142	837	73
1/27/03	299,412	135	913	79
1/28/03	300,692	141	926	89
1/29/03	302,224	135	892	81
1/30/03	303,603	135	871	74
1/31/03	305,143	135	897	64
2/1/03	306,434	127	809	55
2/2/03	308,140	128	1,018	54
2/3/03	310,136	117	1,022	56
2/4/03	312,138	118	825	54
2/5/03	314,116	118	800	53
2/6/03	315,876	117	743	53
2/7/03	317,609	109	695	52
2/8/03	318,928	109	547	49
2/9/03	320,540	111	627	50
2/10/03	322,221	112	667	50
2/11/03	323,778	112	681	52
2/12/03	326,087	108	1,167	59
2/13/03	329,517	104	1,847	51
2/14/03	333,066	118	1,768	80
2/15/03	335,641	110	1,341	55
2/16/03	338,724	106	1,380	53
2/17/03	341,522	109	1,245	55

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
2/18/03	343,863	105	1,082	50
2/19/03	346,178	106	1,098	51
2/20/03	348,334	109	952	48
2/21/03	350,699	104	936	47
2/22/03	352,189	102	838	45
2/23/03	354,433	104	862	46
2/24/03	356,380	105	836	49
2/25/03	358,631	107	1,086	52
2/26/03	360,929	111	1,018	54
2/27/03	363,442	120	1,152	54
2/28/03	365,549	174	960	57
3/1/03	366,933	320	960	
3/2/03	368,320	362	825	
3/3/03	369,537	449	851	
3/4/03	370,826	498	898	
3/5/03	372,011	520	820	
3/6/03	373,199	530	835	
3/7/03	374,528	556	847	
3/8/03	375,580	580	900	
3/9/03	376,914	539	870	
3/10/03	377,864	515	920	
3/11/03	379,237	521	988	
3/12/03	380,789	518	1,137	
3/13/03	382,558	478	1,212	
3/14/03	384,864	392	1,513	
3/15/03	394,409	385	6,036	
3/16/03	400,695	276	3,467	
3/17/03	404,768	271	2,524	
3/18/03	407,983	320	2,206	
3/19/03	410,550	401	1,945	
3/20/03	412,979	436	1,882	
3/21/03	415,007	410	1,940	
3/22/03	417,375	393	1,921	
3/23/03	420,121	413	2,048	
3/24/03	422,578	403	1,887	
3/25/03	424,856	439	1,864	
3/26/03	427,064	472	1,928	
3/27/03	429,317	511	1,975	
3/28/03	431,990	500	1,940	
3/29/03	434,369	465	1,918	

Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

Provisional data, storage in acre-feet other data in cubic feet per second.

	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
3/30/03	437,324	389	2,291	
3/31/03	441,241	240	2,737	
4/1/03	445,522	202	2,862	
4/2/03	449,555	194	2,800	
4/3/03	452,948	184	2,351	
4/4/03	456,239	173	2,147	
4/5/03	459,075	163	1,895	
4/6/03	461,803	159	1,784	
4/7/03	464,538	163	1,806	
4/8/03	467,597	203	2,126	
4/9/03	471,218	254	2,440	
4/10/03	474,854	395	2,660	
4/11/03	478,503	536	2,867	
4/12/03	482,167	583	3,097	
4/13/03	486,366	567	3,315	
4/14/03	491,349	645	3,558	
4/15/03	494,538	930	2,837	
4/16/03	496,927	1,126	2,659	
4/17/03	499,849	1,154	2,690	
4/18/03	502,169	1,102	2,431	
4/19/03	503,800	1,076	2,250	
4/20/03	505,230	1,068	2,271	
4/21/03	507,439	1,160	2,532	
4/22/03	508,710	1,192	2,243	
4/23/03	509,859	1,249	2,116	
4/24/03	511,585	1,228	2,228	
4/25/03	513,315	1,166	2,294	
4/26/03	514,923	1,119	2,371	
4/27/03	517,155	1,100	2,519	
4/28/03	520,096	1,059	2,829	
4/29/03	522,172	1,066	2,580	
4/30/03	523,546	1,142	2,166	
5/1/03	525,170	1,126	2,262	
5/2/03	526,756	1,100	2,214	
5/3/03	529,893	1,024	2,954	
5/4/03	534,553	926	3,440	
5/5/03	538,010	934	3,388	
5/6/03	541,138	1,035	3,046	
5/7/03	544,192	1,079	3,369	
5/8/03	546,317	1,353	2,888	

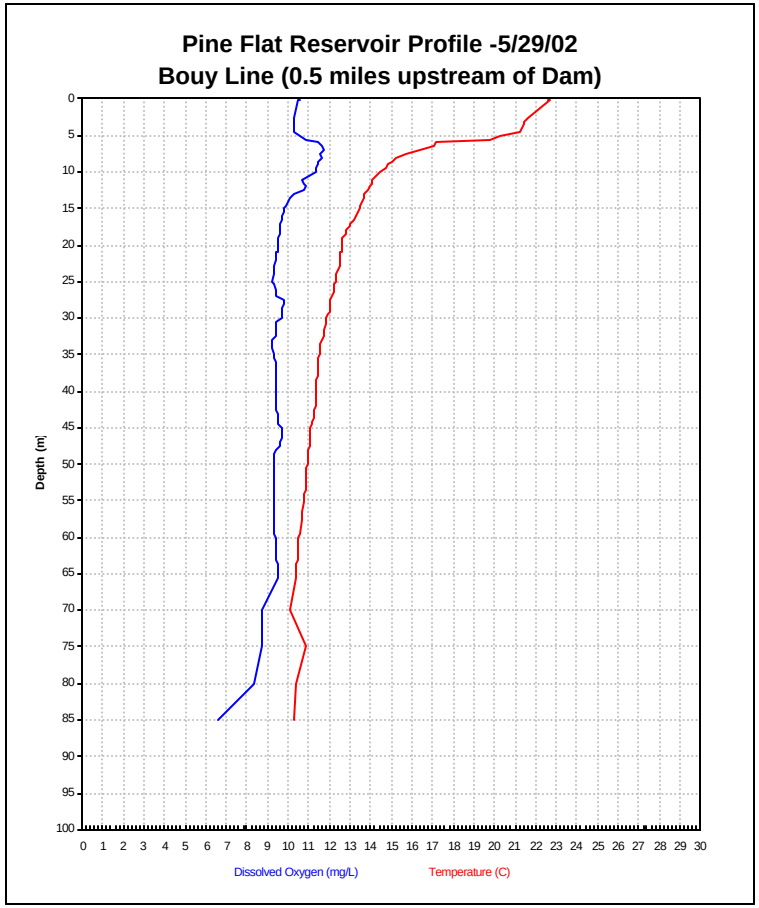
Appendix A - Summary of Daily Hydrologic Data for Pine Flat and the Kings River.

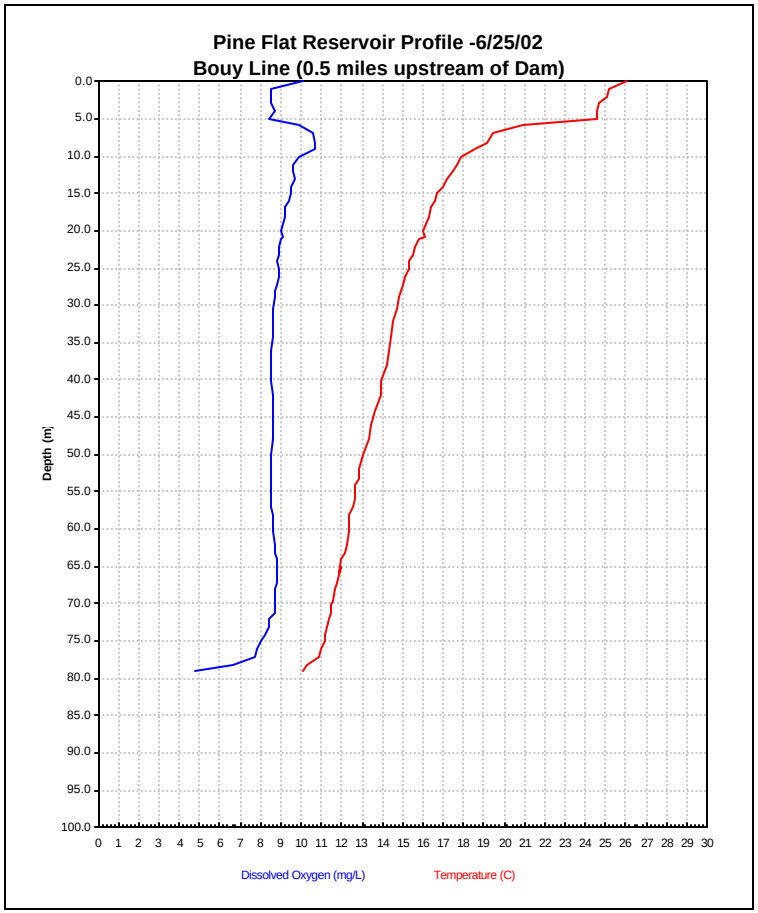
Provisional data, storage in acre-feet other data in cubic feet per second.

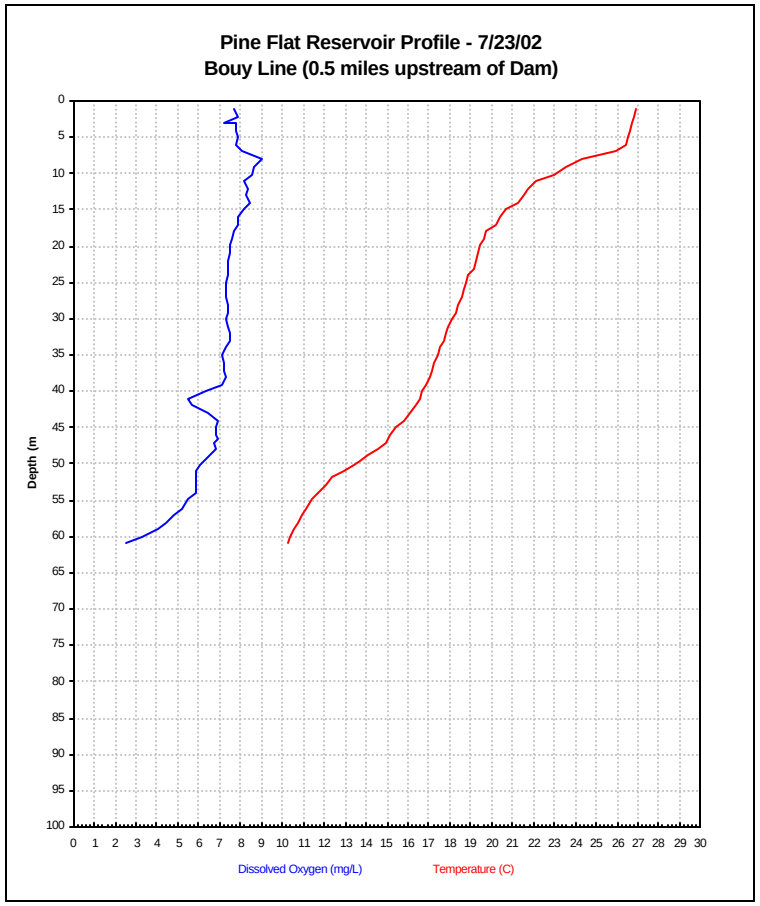
	Pine Flat Storage acre-feet	Kings River for Irrigation cfs	Pre Project Piedra cfs	Measured Flows Below Fresno Weir cfs
5/9/03	547,979	1,350	2,619	
5/10/03	549,642	1,322	2,537	
5/11/03	551,607	1,356	2,628	
5/12/03	554,091	1,474	3,083	
5/13/03	557,440	1,667	4,013	
5/14/03	561,835	1,796	5,276	
5/15/03	566,507	1,876	5,361	
5/16/03	572,420	2,014	6,155	
5/17/03	578,322	2,002	6,504	
5/18/03	584,783	2,037	6,952	
5/19/03	592,035	2,211	7,605	
5/20/03	600,139	2,371	8,239	
5/21/03	609,245	2,387	9,254	
5/22/03	620,603	2,425	10,612	
5/23/03	633,403	2,456	11,548	
5/24/03	645,786	2,439	11,642	
5/25/03	658,153	3,138	12,332	
5/26/03	669,699	3,406	12,016	
5/27/03	683,505	3,510	13,827	
5/28/03	699,834	3,640	15,495	
5/29/03	716,226	3,846	15,265	
5/30/03	731,087	3,988	14,620	
5/31/03	743,906	4,119	13,412	

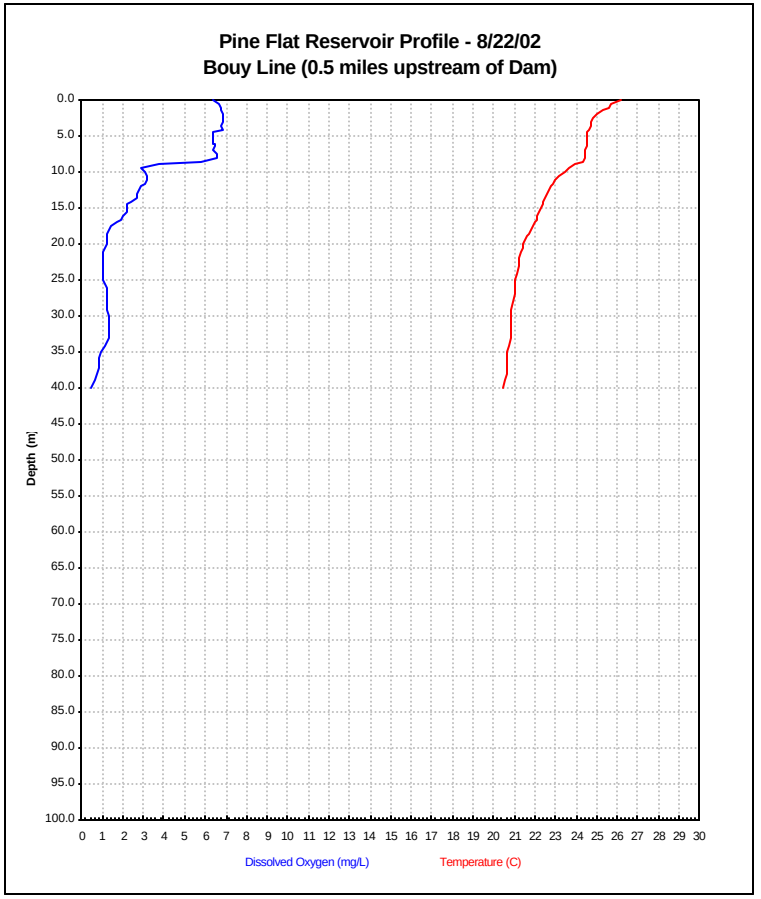
Appendix B

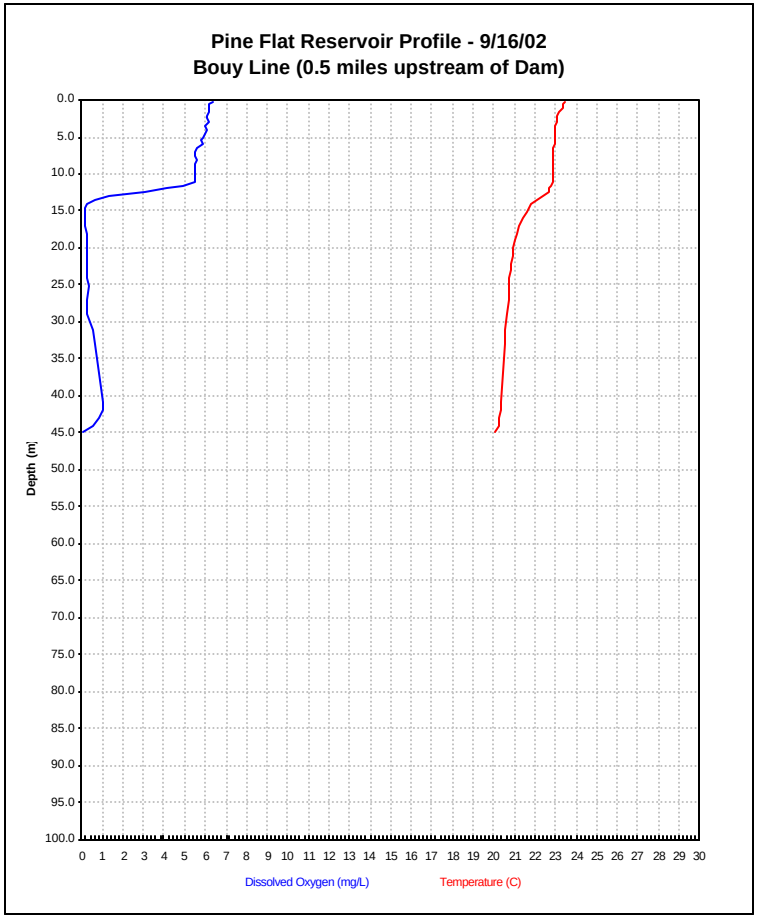
Monthly vertical reservoir temperature and dissolved oxygen profile measurements at Pine Flat Reservoir May 2002 through May 2003

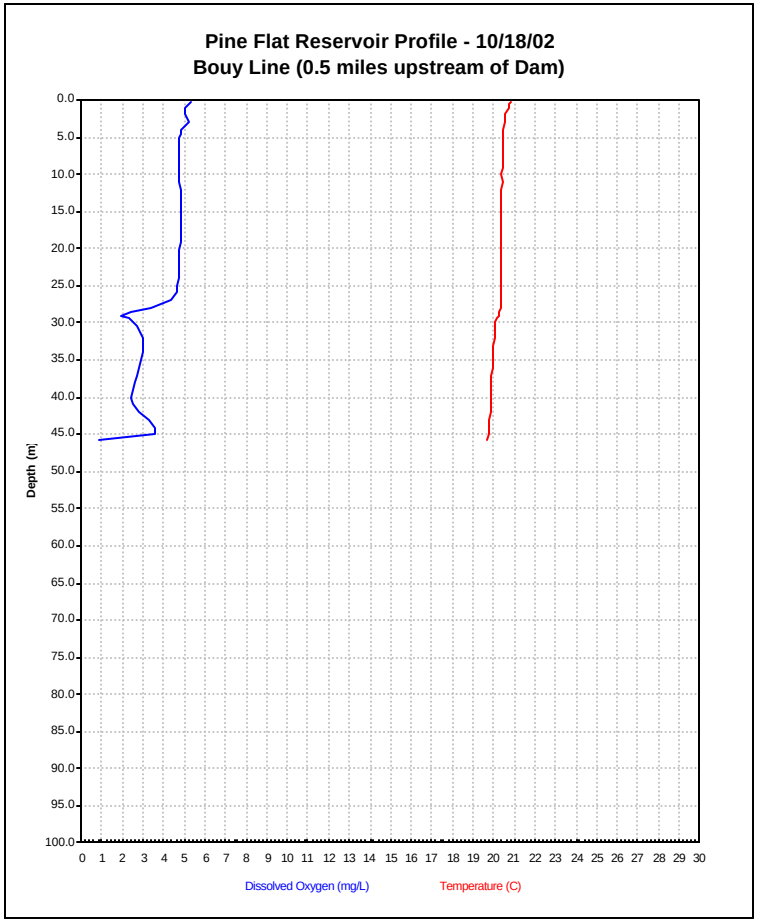

Pine Flat Reservoir Profile -5/29/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)

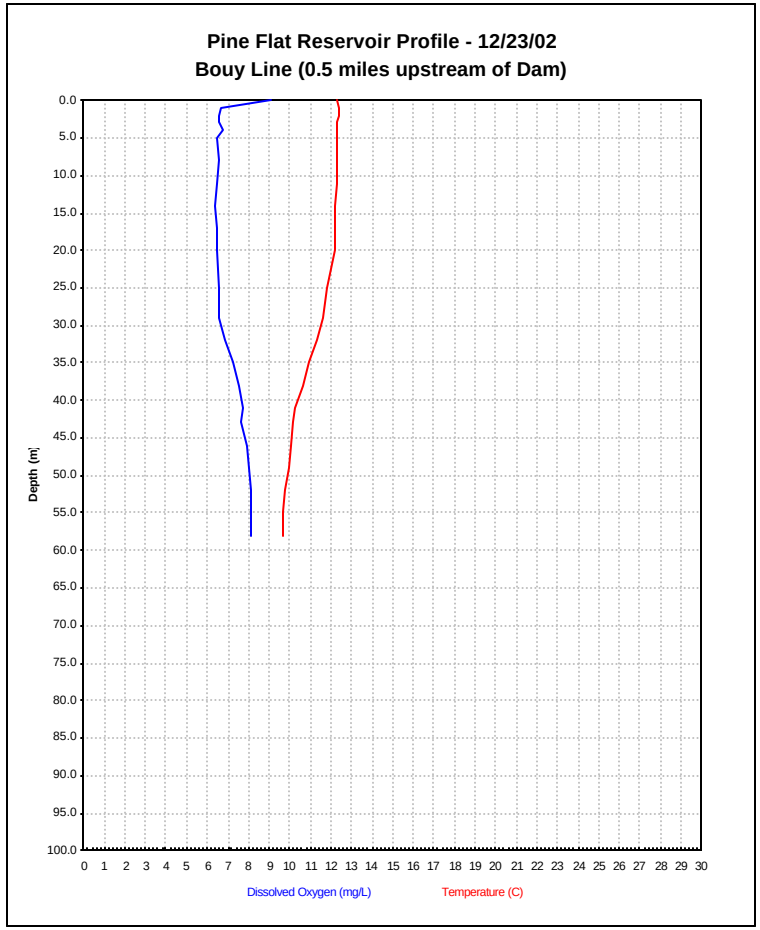

Pine Flat Reservoir Profile -6/25/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)

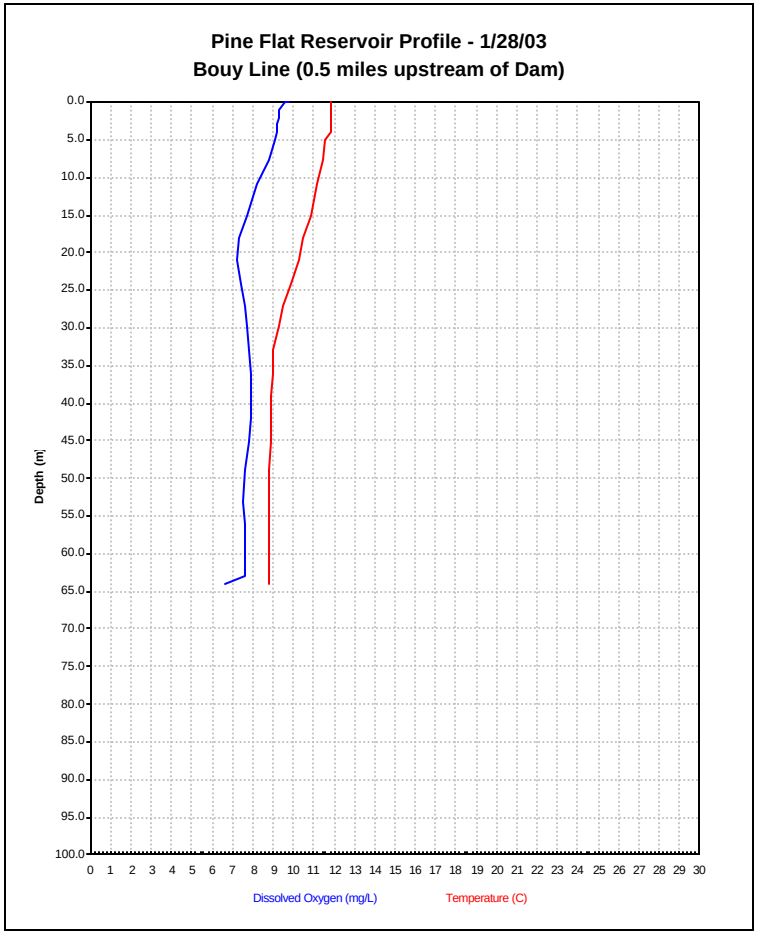

Pine Flat Reservoir Profile - 7/23/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m
Dissolved Oxygen (mg/L)
Temperature (C)

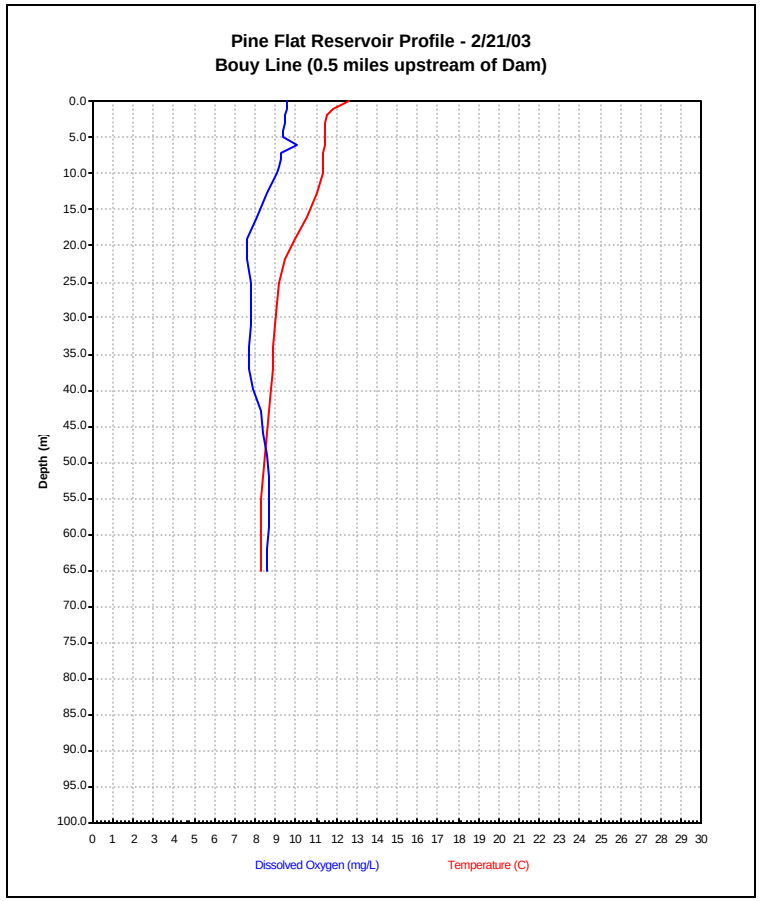

Pine Flat Reservoir Profile - 8/22/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
Dissolved Oxygen (mg/L)
Temperature (C)

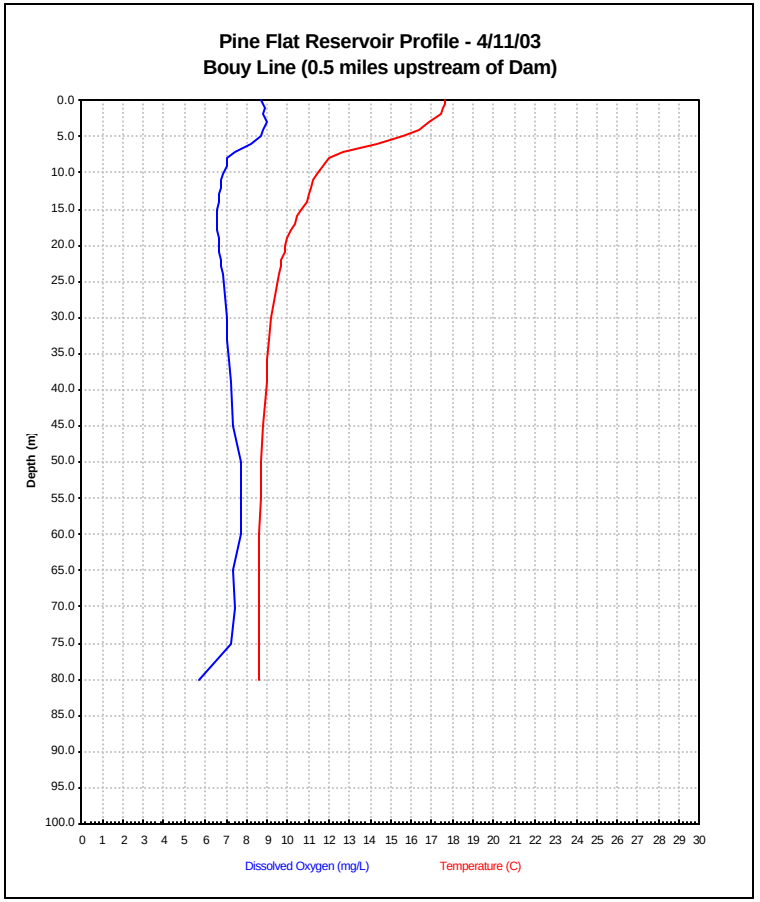

Pine Flat Reservoir Profile - 9/16/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)

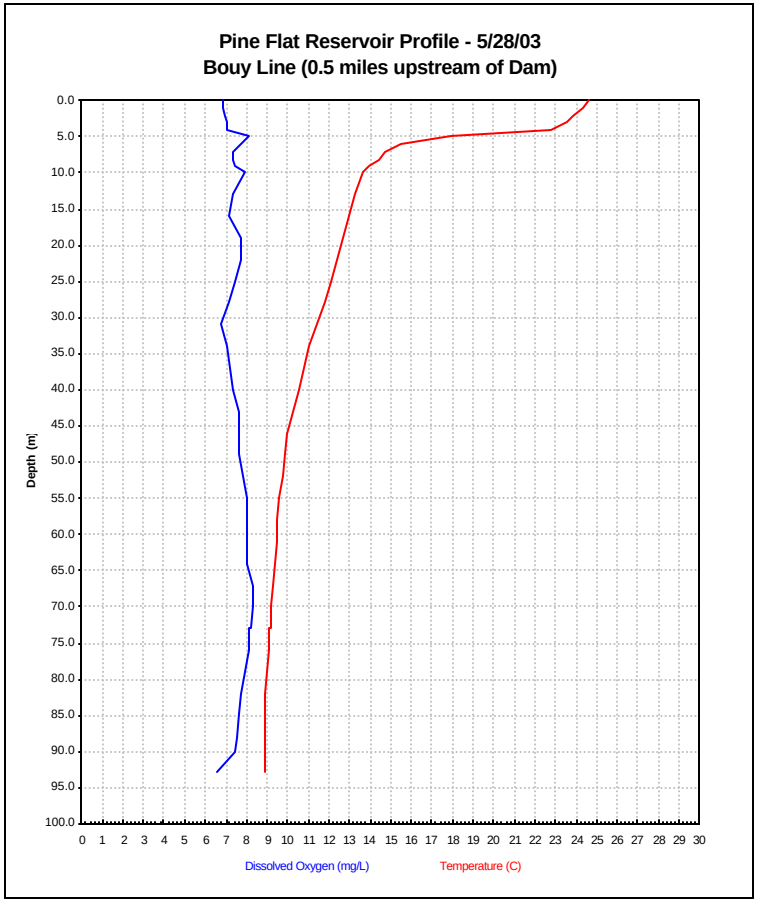

Pine Flat Reservoir Profile - 10/18/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)


Pine Flat Reservoir Profile - 12/23/02
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)


Pine Flat Reservoir Profile - 1/28/03
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)


Pine Flat Reservoir Profile - 2/21/03
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)

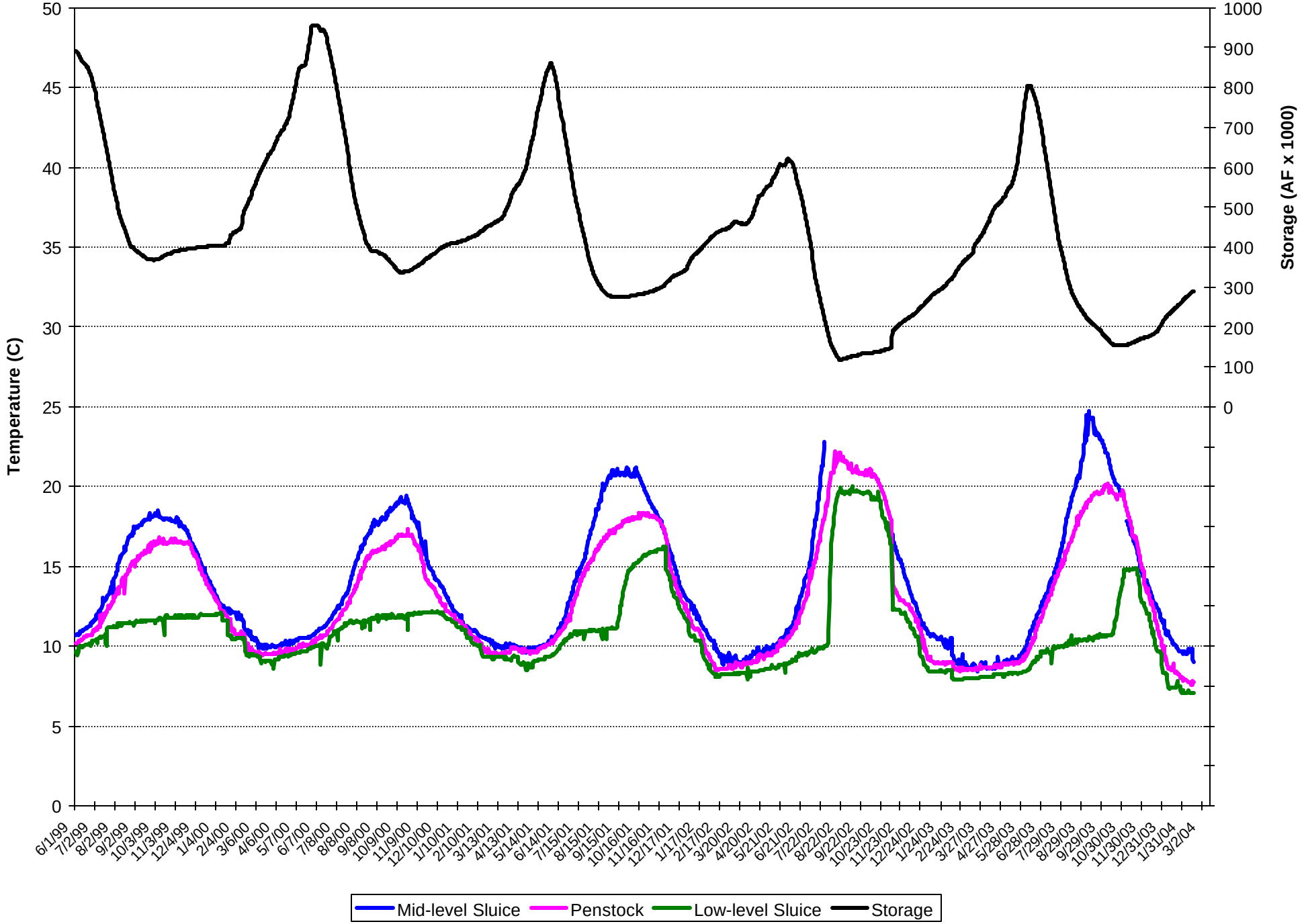

Pine Flat Reservoir Profile - 4/11/03
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0 5.0 10.0 15.0 20.0 25.0 30.0 35.0 40.0 45.0 50.0 55.0 60.0 65.0 70.0 75.0 80.0 85.0 90.0 95.0 100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)


Pine Flat Reservoir Profile - 5/28/03
Bouy Line (0.5 miles upstream of Dam)
Depth (m)
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0
90.0
95.0
100.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Dissolved Oxygen (mg/L)
Temperature (C)

Appendix C

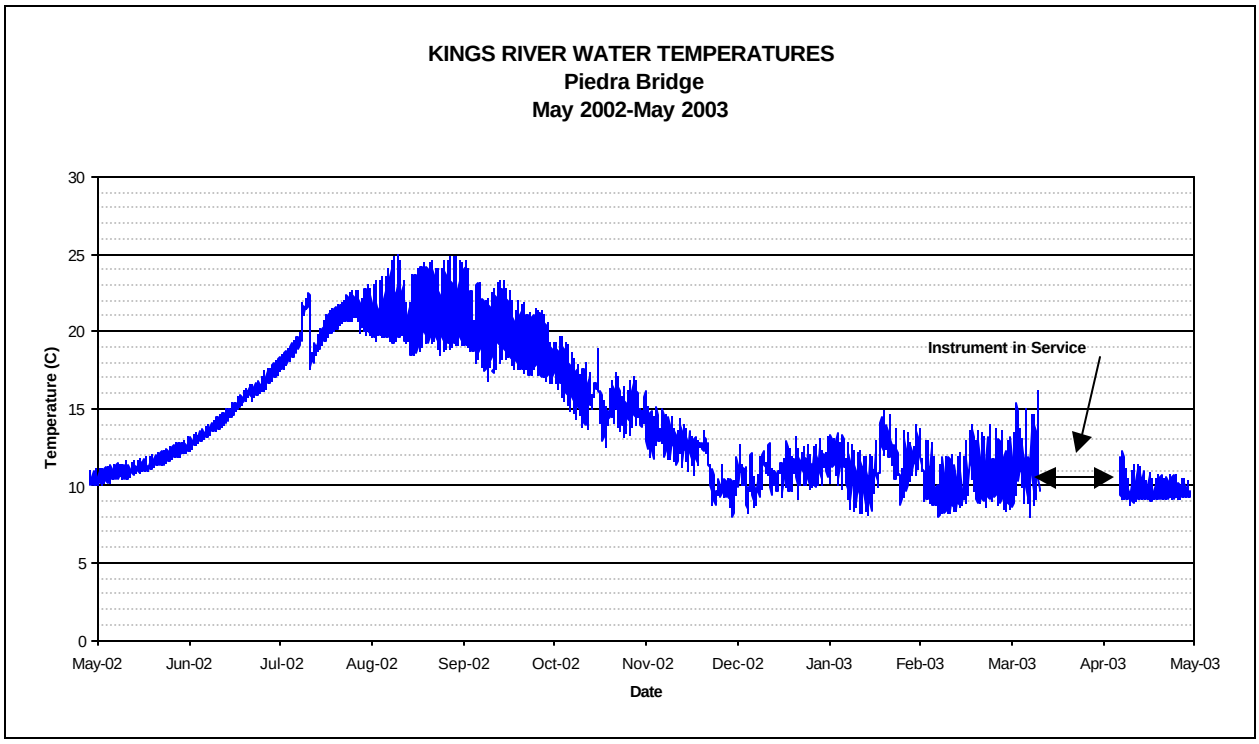
Daily Water Temperature Monitoring
At each of the individual outlet ports on Pine Flat Dam

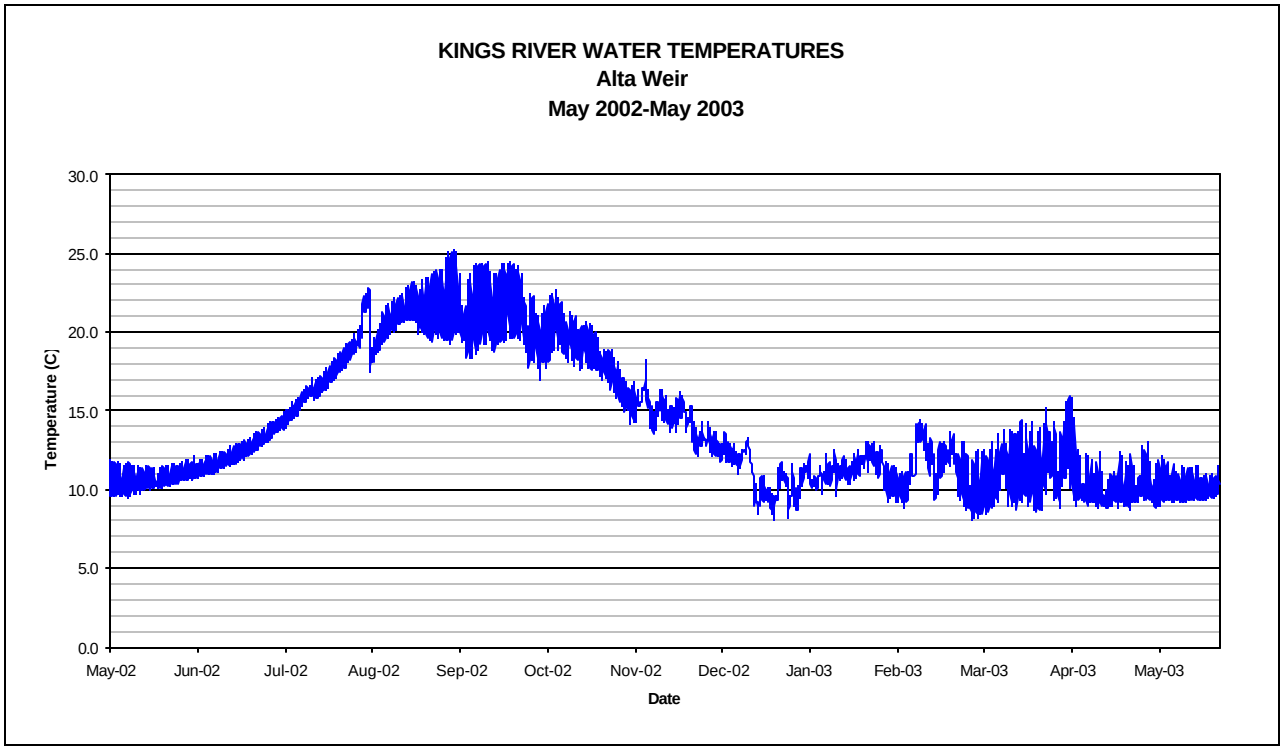
Pine Flat Reservoir: Daily Temperature and Storage Readings

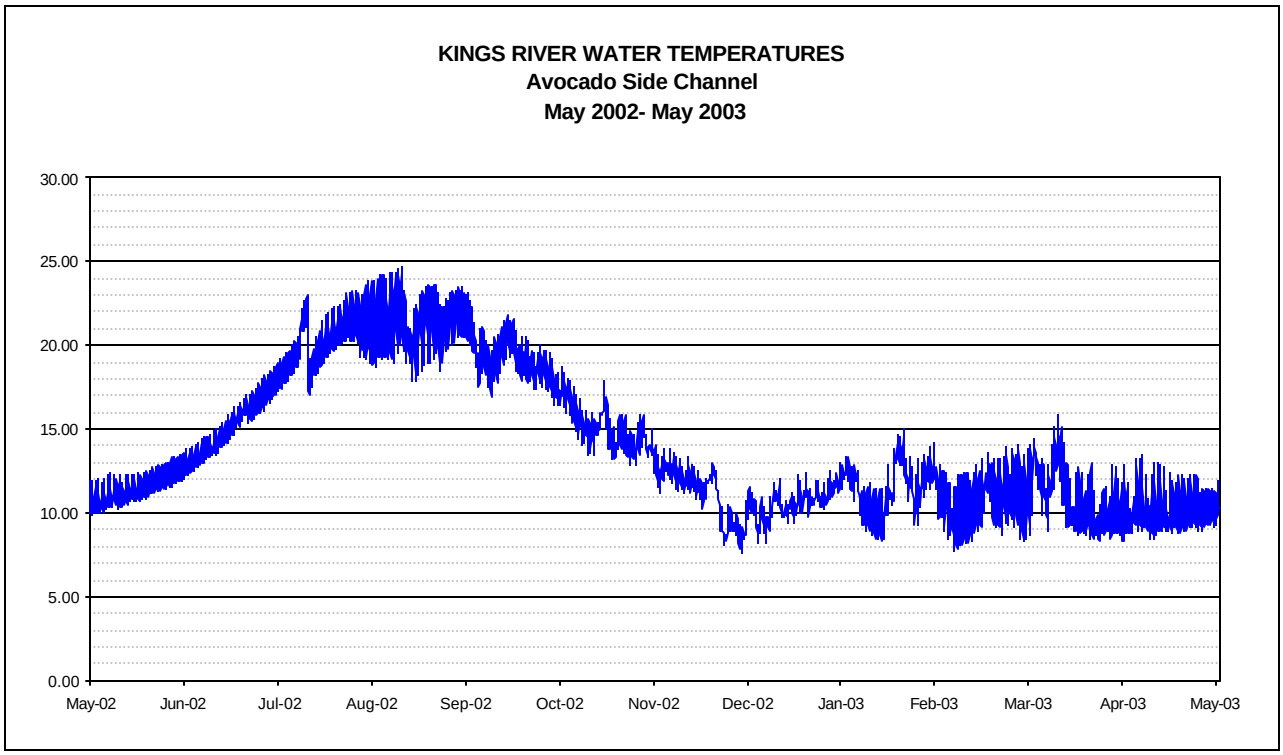


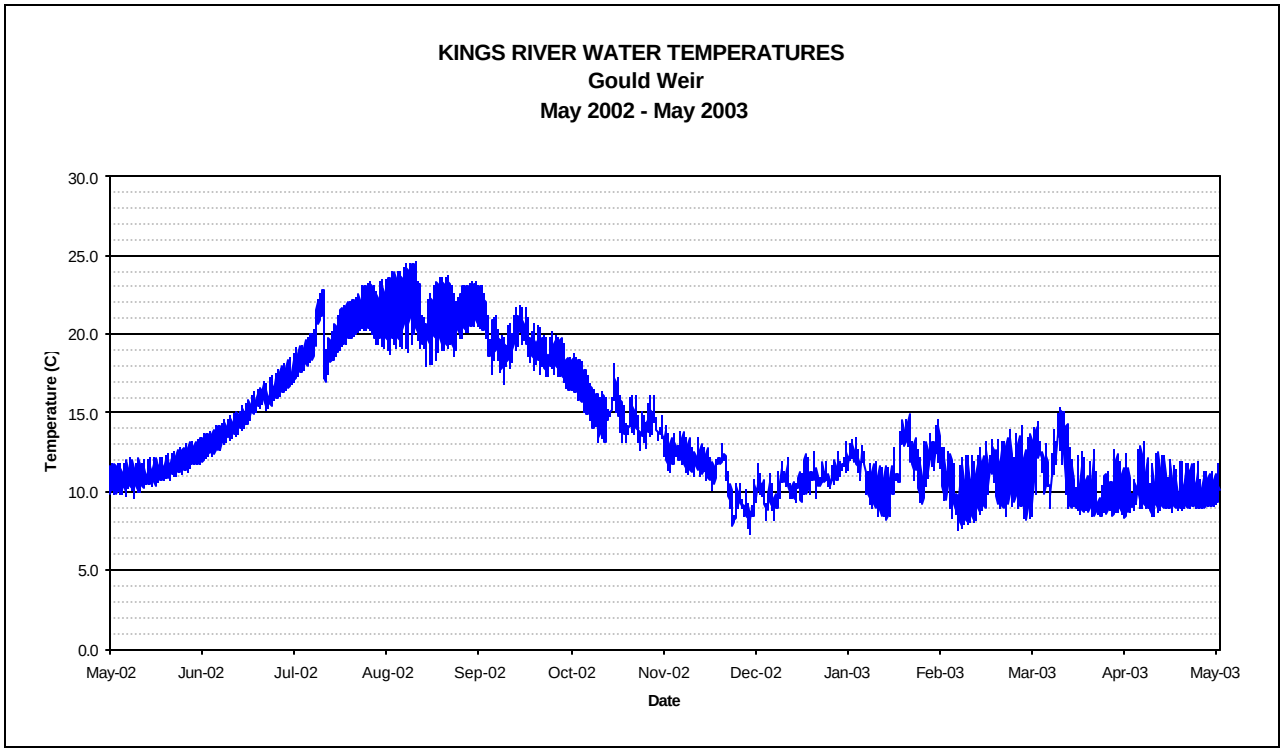
Appendix D

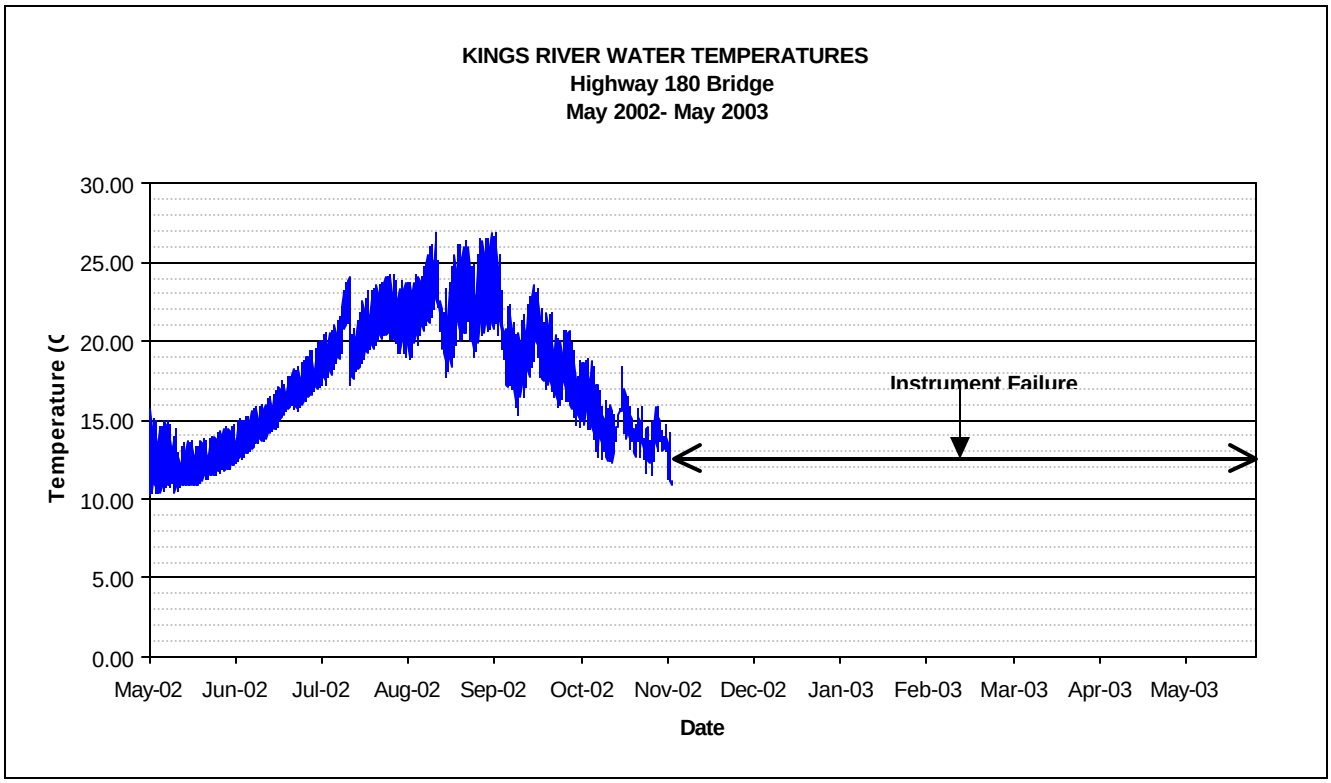
Results of water temperature monitoring at locations other than ACOE Bridge and Fresno Weir


KINGS RIVER WATER TEMPERATURES
Piedra Bridge
May 2002-May 2003
Temperature (C)
30
25
20
15
10
5
0
Instrument in Service
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Date


KINGS RIVER WATER TEMPERATURES
Alta Weir
May 2002-May 2003
Temperature (C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Date


KINGS RIVER WATER TEMPERATURES
Avocado Side Channel
May 2002- May 2003
30.00
25.00
20.00
15.00
10.00
5.00
0.00
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03


KINGS RIVER WATER TEMPERATURES
Gould Weir
May 2002 - May 2003
Temperature (C)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Date


KINGS RIVER WATER TEMPERATURES
Highway 180 Bridge
May 2002- May 2003
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Temperature (C
Instrument Failure
May-02
Jun-02
Jul-02
Aug-02
Sep-02
Oct-02
Nov-02
Dec-02
Jan-03
Feb-03
Mar-03
Apr-03
May-03
Date

Appendix E

DRAFT

Supplemental Fish Stocking Element of the Fishery Management Program for the Lower Kings River from Pine Flat Dam Downstream to the Highway 180 Bridge and for, Pine Flat Reservoir and Avocado Lake

(Element #N3)

Prepared by

Technical Steering Committee

for the

Kings River Fisheries Management Program

California Department of Fish and Game
Kings River Conservation District
Kings River Water Association

March 11, 2003

Introduction

On May 28, 1999 the "Framework Agreement of the Kings River Fisheries Management Program (FMP)" was signed by the Kings River Water Association, California Department of Fish and Game (CDFG), and Kings River Conservation District to improve the fisheries of the Kings River downstream of Pine Flat Dam and within Pine Flat Reservoir. Within that agreement was Paragraph (j) which specified that "The Department in consultation with the Association, the District and appropriate local fishing organizations, will develop and implement a focused supplemental trout stocking program for Pine Flat Reservoir and the Kings River below Pine Flat Dam…". In May 2000, the Technical Steering Committee (TSC) developed a "5-Year Implementation Plan." Within that plan is Element #N3-Supplemental Trout Stocking, which calls for development of a comprehensive plan to address stocking and revitalizing the coldwater fishery should a critical hydrological cycle (i.e., drought and/or a temperature event) occur. This plan is written to fulfill the supplemental stocking tasks of the Framework Agreement and the 5-Year Implementation Plan.

The supplemental stocking of hatchery produced trout and eggs is intended to be short-term annually approved element of the KRFMP. Objectives of the hatchery program to provide supplemental trout include (1) support recreational angling opportunities for trout within the lower Kings River on an interim basis, (2) supplement in-river trout production to facilitate and expedite enhancement of the wild trout population, and (3) provide fish that may be needed for other programs developed through the adaptive management process. As the quality and availability of suitable habitat within the lower river increases in response to habitat enhancement projects implemented through the FMP over time, successful in-river spawning and juvenile production are anticipated to increase. This should, contribute to an overall increase in population abundance of wild trout within the river. As wild trout abundance increases in response to those actions implemented through the fishery enhancement plan, modifications will be made to the KRFMP supplemental stocking plan. This can include changes to the size classes of trout to be stocked and an overall reduction in the number of hatchery fish released each year into the river. As a wild trout population becomes self-sustaining, the hatchery supplementation program by the KRFMP will be reviewed and modified as part of the overall management program. The CDFG will continue their baseline fish stocking practices within the watershed. CDFG's baseline stocking of catchable trout is primarily conducted in the "Catchable" section of the river, and not in the "Catch and Release" section of the river (Figure 1).

For development of this plan, the TSC reviewed past and current stocking practices. Creel survey data, tagging studies and reports were reviewed. Also, reviewed were trout production capabilities of the San Joaquin Hatchery and costs to raise and stock trout.

The CDFG has fishery management responsibilities directed by the State Constitution, and other laws, regulations and policies. All applicable CDFG and Fish and

Game Commission guidelines and regulations will be followed in implementing the KRFMP Supplemental Stocking Plan.

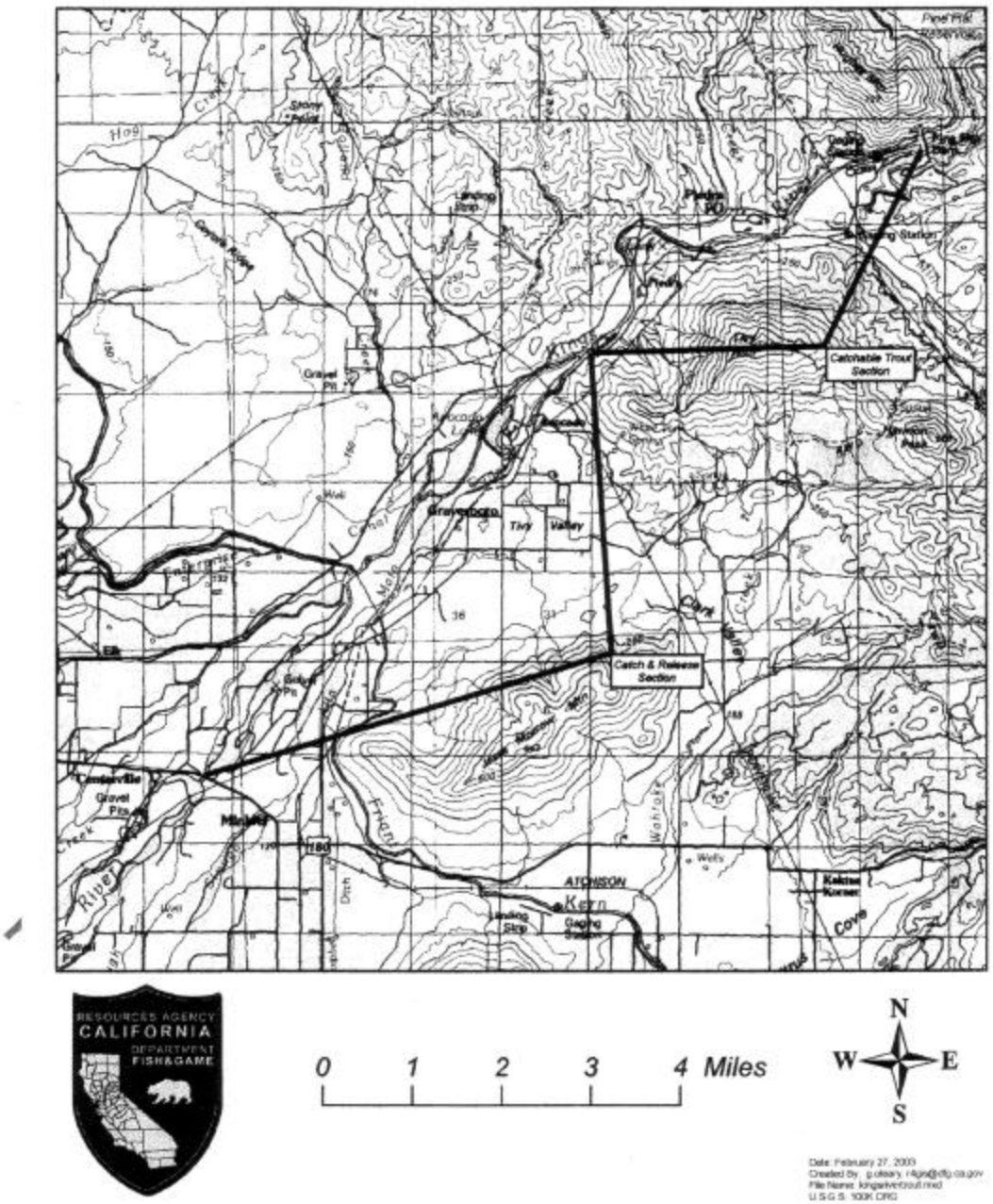


Figure 1: Fishing Regulation Zones of the Lower Kings River 2003.

Overview of Historic Stocking Practices

Pine Flat Reservoir and Avocado Lake

Trout

The fishery management programs (baseline) for these reservoirs have been developed by CDFG over many years. The CDFG produces and plants catchable trout for annual fishery programs in Pine Flat Reservoir and Avocado Lake at the rates and timing listed below.

Pine Flat Reservoir:	25,000 lbs or about 50,000 catchable Rainbow Trout; stocked from November through May.
Avocado Lake:	6,500 lbs or about 13,000 catchable Rainbow Trout; stocked from November through May.

Species other than trout

Other species of fish are also stocked in Pine Flat Reservoir on either a regular or irregular basis. The species, size and typical numbers that have been stocked in any one year include 30,000 subcatchable Chinook salmon, 100,000 fingerling kokanee salmon, several thousand Florida strain largemouth bass fingerlings (~ 2-4 inches in length) and 2,500 Florida strain bluegill sub-adults or adults (~ 2-6 inches in length).

Lower Kings River

The CDFG's baseline fishery management plan for the lower Kings River has been developed over many years. CDFG has produced and stocked a combination of eggs, fingerling, subcatchable, catchable and large size trout for the annual fishery program in the lower Kings River. The elements of the program are adjusted regularly to match the CDFG's program objectives in a given year or period of years.

Trout Eggs

In the past both brown and rainbow trout eggs have been stocked on an infrequent basis. When these plantings have occurred the numbers have ranged from 100,000 to 900,000 eggs in any one year. Planting occurred during the low flow period. Past frequency of plantings was highly variable. Egg, labor and material availability were also considered. Planting techniques included construction and use of artificial redds, Whitlock-Vibert boxes and temporary streamside incubators.

Fingerling Trout

Stocking of rainbow trout fingerlings has occurred on an infrequent basis. When utilized, about 20,000 to 100,000 fingerlings have been stocked in any one year in the

lower river, typically in the spring. The planting took about a week to complete and fish were distributed to multiple locations along the river.

Subcatchable Trout

On an annual basis, CDFG, as part of the put and grow program stocks approximately 24,000 subcatchable Rainbow trout. These subcatchables range in size from 4-6 inches. Stocking occurs once per year and is typically in the fall once water temperatures have cooled and are less variable in both temperature and flow. Efforts are made to distribute these fish throughout the lower river.

Catchable Trout

CDFG's catchable trout program is managed as a "put and take" program with a focus on harvest. The number and timing of trout stocking has varied over time in response to changing regulations, public desire and available resources. The current catchable rainbow trout program is 18,000 lbs or about 36,000 catchable rainbow trout annually. These fish typically average about 12 inches and ½pound in size.

Since initiation of the KRFMP in 2000, the CDFG with input from the TSC and PAG has reviewed and modified the stocking practices for the lower river. Catchable trout are stocked throughout the year. Stocking occurs once per week during high flow periods (roughly March through September) and twice per week during the low flow periods (about October through February). There are currently four stocking locations between Pine Flat Dam and Cobbles Weir.

Large Trout

Rainbow trout (typically greater than 2 pounds in weight and 16 plus inches in length) are available for stocking in the lower Kings River during some years. These large fish were stocked on an as available basis. When stocked, a few large trout are mixed with the normal catchable trout plant. Stocking of these fish occurs only in the zone between Pine Flat Dam and Cobbles Weir.

Trout Stocking Guidelines

The CDFG catchable trout stocking is guided by Fish and Game Commission policy which requires the postponing of stocking trout during the warm water period (water temperatures greater than 75 degrees Fahrenheit [24 degrees Celsius]). The CDFG will hold the trout at the San Joaquin Hatchery, if possible, and stock the trout when water temperatures become suitable. Catchable trout were stocked in the put-and-take zone or other locations deemed appropriate by the CDFG in consultation with its stakeholders.

Species Other Than Trout

No species other than trout have been stocked on a regular or planned basis in the Kings River below Pine Flat Reservoir. Historically when Pine Flat Reservoir would

spill, some of the fish (e.g. spotted bass and white catfish) from the reservoir were moved downstream and became established in the lower river.

Proposed Annually Approved Stocking Program

Pine Flat Reservoir and Avocado Lake

The supplemental fishery management program for these waters now integrates the interests and processes defined in the KRFMP through regular input from stakeholders.

Trout

The trout stocking programs for Pine Flat Reservoir and Avocado Lake were reviewed and no changes are recommended at this time. This program will be reviewed in the future as part of the adaptive management process and changes will be recommended if appropriate.

Species Other than Trout

The stocking programs of species other than trout were reviewed and no changes are being recommended at this time. This program will be reviewed in the future as part of the adaptive management process and changes will be recommended if appropriate.

Lower Kings River

Trout

In general the proposed elements of the annual stocking program are premised upon the principles of adaptive management as described and applied through the KRFMP. It relies on the collective knowledge of participants familiar with the lower river. It is anticipated that adjustments to the allocations between and among various age classes of trout (sizes) will occur as enhancement of habitat and the self sustaining trout population occurs.

This section of the element will separate trout management in the river into two (2) general areas which are derived from the current California Sport Fishing Regulations. The "Catchable" section of the river extends downstream from the Dam to Cobbles (Alta) Weir. The "Catch and Release" section extends from Cobbles Weir downstream to the Highway 180 crossing. This "Catch and Release" section is further subdivided into a sustained trout fishery from Cobbles Weir to Fresno Weir; and opportunistic trout angling from Fresno Weir to the Highway 180 crossing. Management strategies for the "Catchable" and "Catch and Release" areas are different. For ease of explanation the program is defined for each of these areas separately.

Quantities of trout defined in the proposed stocking plan below are based on: 1) the KRFMP; 2) assessment of the numbers of trout proposed for stocking and the self sustaining trout population; 3) other fish existing in the river system; 4) assessment of current and historic trout stocking practices; and 5) the expectation that adjustments to these quantities will be suggested based upon future monitoring results.

Trout Eggs

Eyed rainbow trout eggs may be hatched and stocked using the permanent streamside incubators constructed as a result of Element C-2002-5. Approximately 100,000 to 200,000 eggs may be stocked each year. The exact number of eggs will depend upon the annual egg allotments, collection from wild trout stocks, or other programs developed through the adaptive management process. Additional permanent streamside incubators or temporary streamside incubators may be considered in the future through the adaptive management process. The genetic makeup of eggs may vary depending on the objectives of the overall program. These eggs are currently split about ½ and ½ between the "Catchable" and "Catch and Releases" areas.

Fingerling Trout

No fingerling trout element is being recommended for the program at this time. The KRFMP trout egg element appears to produce similar results at a lower cost. A fingerling stocking program may be considered in the future if deemed appropriate through the adaptive management process.

Subcatchable Trout

Approximately 24,000 subcatchable rainbow trout may be stocked as part of the put and grow element of the program. Subcatchables range in size from 4-6 inches. Stocking would occur once per year and typically in the fall when water temperatures and flows have subsided and stabilized. Efforts will be made to distribute these fish throughout the system in locations deemed appropriate by CDFG who will consult with its stakeholders and members of the KRFMP. The genetic makeup of subcatchables may vary based on the objectives of the overall program.

Catchable Section (Pine Flat Dam to Cobbles Weir)

This section of the river will be managed for "put and take" objectives through the stocking of catchable size trout (currently averaging ½ pound each) by the CDFG. Anglers have a strong interest in maintaining a harvest opportunity in this area. Habitat work may be done in some sections of this portion of the river to encourage spawning of trout and to increase the self sustaining portion of the trout population and to increase habitat diversity for trout of all sizes. However, a self sustaining trout population cannot meet the high harvest demands of anglers on this reach of river. This demand can only be met with the stocking of hatchery products.

Catchables will be stocked year around. Stocking should occur once per week during high flow periods and twice per week during the low flow periods. There are currently four stocking locations that are utilized in rotation between Pine Flat Dam and Cobbles Weir. Additional stocking sites will be examined as needed or desired. Stocking of these or other fish in other reaches of the river could occur as part of the adaptive management process.

Catchable Trout

The CDFG baseline catchable rainbow trout program will remain at 18,000 pounds or about 36,000 catchable rainbow trout annually. These trout average 2 fish per pound (about 12 inches in size). The Incremental Catchable Trout element of the KRFMP Supplemental Stocking Plan below would add to this element in the years it is implemented.

Large Trout

Large rainbow trout (typically greater than 2 pounds in weight and 16 plus inches) are occasionally available from CDFG's hatchery for stocking in the lower Kings River during some years. These large fish may be stocked on an as available basis. When stocked, a few of the large trout would be mixed with the normal catchable trout plant. Stocking of these fish would occur between Pine Flat Dam and Cobbles Weir. This program is well received by anglers utilizing this reach of river. This program part of the CDFG baseline program.

Incremental Catchable Trout Program

This section of the catchable trout element would consist of an additional 10,000 pounds or approximately 20,000 additional ½pound catchable trout. This would increase the planting of catchable trout from the current 18,000 pounds to 28,000 pounds annually. These fish would be produced and then stocked in the Kings River in the "put and take" section of the river only in years when doing so is determined to be necessary.

Costs

The CDFG will continue to fund the production and stocking for the baseline trout elements of the program consistent with its mandates, policies and fiscal capabilities. Likewise, the bulk of the KRFMP funds are being spent on habitat improvement and other actions to enhance the self sustaining rainbow trout fishery in the river.

The additional or incremental cost associated with implementation of the proposed Incremental Catchable Trout Stocking Element is $20,000 to be annually approved within the 5-Year Plan. These costs would be encumbered by the parties to the KRFMP. The CDFG would be tasked with the implementation of this program. The CDFG's San Joaquin Hatchery has the capacity to produce the additional trout in addition to the baseline programs, but would rely on the KRFMP budget to support the production and stocking of the "Incremental Catchable Trout Element" of the program.

Catch and Release Section (Cobbles Weir to Highway 180 Crossing)

The upper portion of this section of the river will be managed for a self sustaining trout population (reproduction, rearing and growing of trout) within the river. The lower portion of this section will be managed for opportunistic angling. The emphasis will be on "Catch and Release" angling. Harvest of some fish may be allowed as appropriate as determined through the monitoring and adaptive management process and through the implementation of angling regulations by the Fish and Game Commission. An emphasis towards stocking younger age classes of trout, including eggs will occur in the "Catch and Release" section of the river when evidence of inadequate numbers of wild trout are indicated or documented. The progression of preferred stocking strategies will start with eggs to subcatchables to adults. However, specific stocking programs favoring natural stocks may be developed to address specific problems identified through the adaptive management process (e.g. stocking wild trout originating from the Kings River above Pine Flat Reservoir to introduce varied genetics into the population or to provide spawning size fish).

Quantities noted in the proposed stocking plan are derived from 1) the KRFMP which emphasizes successful habitat and fish population enhancement over hatchery stocking programs in this section of the river; 2) assessment of the numbers of trout proposed for stocking and the self sustaining trout and other fish existing in the river system; 3) historic and current stocking practices; and 4) the expectation that adjustments to these quantities will be suggested based upon future monitoring results. No

recommendations specific to this river section are being made at this time other than those that apply to the river from the Dam to Highway 180.

Species Other than Trout

No species other than trout have been stocked on a regular or planned basis in the Kings River below Pine Flat Reservoir. No stocking of species other than trout are being recommended by the TSC at this time.

Monitoring

The success of the various elements of supplemental trout stocking will be evaluated through the monitoring program. Monitoring activities that will provide insight to the effectiveness of the stocking program include; creel surveys, trout tagging studies, angler questionnaire boxes, electrofishing surveys, angler log books, or other programs recommended by the TSC and approved by the Executive Policy Committee. Status of the proposed stocking program and monitoring results will be included as part of the annual technical report.

Periodic or New Activities

In general, periodic activities will occur as onetime efforts. Each activity would be approved by the ExCom prior to implementation. If so desired an activity could be repeated successive times with additional ExCom approval. Some activities may occur as part of existing program elements (ie Reintroduction of Wild Trout) to develop information that may be needed to develop a management or monitoring plan.

Reintroduction of Wild Trout

This action is already being planned under Element #C5 (2000), N-2001-1 (2001), and C2002-10 (2002) of the 5-Year Implementation Plan. To revitalize the juvenile and adult trout population in the lower river, wild rainbow trout from the Kings River drainage in the Sierra Nevada Mountains or other locations recommended by the TSC, and approved by the Department could be captured, transported, and stocked in the lower river. Only a few trout would be collected and removed from each pool from the collection site(s) to avoid impacts to the donor populatin of trout . The relocation of wild trout would likely occur primarily in the fall and winter. The stocking of 500 wild trout of various sizes and ages is estimated as the number that may be introduced for a year or series of years.

Recommendation

The TSC recommends approval of this proposed supplemental stocking plan, with the expectation that future changes to the plan will be recommended through the KRFMP processes. Any recommended changes to the plan will be based upon monitoring results, changes in the quality and availability of trout habitat and other factors.

Appendix F

DRAFT

STUDY PLAN

for

Post-project Monitoring Plan for the Thorburn Fish Spawning and Rearing Channel, Kings River, Fresno County, California.

Prepared by

Technical Steering Committee

for the

Kings River Fisheries Management Program

California Department of Fish and Game
Kings River Conservation District
Kings River Water Association

April 2003

Introduction

The California Department of Fish and Game (CDFG), the Kings River Conservation District (KRCD), and the Kings River Water Association (KRWA), have entered into a joint FMP to improve instream habitat and the trout fishery on the lower Kings River. The Kings River Fisheries Management Program Framework Agreement adopted May 1999 outlines management objectives for the next ten years. One of the initial components of Kings River Fisheries Management Program was the creation of the Thorburn Spawning Gravel Project. The multi-use channel was designed primarily as a trout spawning/rearing channel. The five-year implementation plan calls for the development of a monitoring plan to evaluate the merits of the project (Element C2). Monitoring results will be used to evaluate the effectiveness of the project and determine if modification or improvements to the channel or operations are necessary.

Study Objectives

The objective of this study is to evaluate the constructed channel to determine if is functioning as designed and collect baseline information. The channel is still under construction with additional habitat features yet to be added. The main function of the channel at this time is to provide adult trout escape from high flows in the main channel and rearing of young fish.

Monitoring will target trout; however use by other fish species will be documented. Studies may include redd surveys to determine spawning use and timing by trout, fish population estimates, and an assessment of the physical habitat parameters and benthic macroinvertebrate component.

Methods

Redd Surveys

The timing of trout spawning on the lower Kings River is not known with any certainty. Rainbow trout typically spawn between late March and early May, depending on water temperature and day length. However, the natural hydrograph downstream of Pine Flat Dam has been changed due to release of water for irrigation purposes. High irrigation flows normally occur from late March through late September may have influence the rainbow trout spawning period. Rainbow trout have been observed spawning in the late December early January period. These trout are the hatchery trout whose spawning period has been changed in the hatchery system over time to spawn in the fall. This was done to produce different strains of rainbow trout so that catchable size fish would be available for stocking waters throughout the angling season. These fall-spawning rainbow trout may have a selective advantage over the typical spring spawning rainbow trout. It is also possible that rainbow trout are spawning during different times of the years (spring and fall).

The spawning channel was designed for adequate spawning flows during the irrigation season (usually beginning late March). At present, the channel lacks adequate overhead and hiding cover to hold spawning trout. It also lacks the deeper pools that would also serve as cover for adult trout. This type of cover will be added over the next few years. At this time the channel most likely will not serve as a spawning channel.

Redd surveys may be conducted weekly from late March through early May to determine if trout or other fishes are attempting to spawn. Redds are identified by freshly scoured gravel sections with a depression upstream and tailspill-mound downstream. These generally occur in areas of upwelling or downwelling of the water flow through suitably sized gravels. The surveyor should wear a long-billed hat and polarized glasses to reduce glare on the water surface. A quality pair of binoculars can assist in viewing areas and observing actively spawning fish. The survey is conducted by walking the entire channel on both sides looking for areas where the gravel is lighter in color (cleaned by tail action). The service road on the east side provides the better view for most of the channel. The surveyor should not walk in the bottom of the channel except to take measurements, taking care not to disturb the redd. Redds will be photographed and location mapped as accurately as possible for future physical measurements.

Measurement for each redd located shall include depth, velocity, distance from nearest bank (Right/Left), length and width of redd, and percent of overhead cover. Redds should not be physically disturbed with the rods or by wading. Core samples may be taken at a later time to determine if a redd is actually present. Notes should be taken regarding fish and wildlife observed, along with condition of the channel. The equipment needed for the survey will be a hat, sunglasses, binoculars, digital camera, flow meter, measuring tape (m), meter stick, and a densiometer. Redd locations will be plotted on a project map and an analysis will be done to determine what physical attributes are present at those sites.

Habitat Typing

The spawning channel will be habitat typed (ref) to determine the various habitat types available. Habitat typing will include pools, runs, cover, gradient, and substrate. Based on these results, the various habitat types will be determined and the locations marked along the bank. From the habitat types available, three sites will be selected to represent three different types using stratified random sampling. It is quite possible there may only be one habitat type in this channel, excluding the pool habitat at the lower end of the channel that is not available to sampling using backpack electrofishers.

Population Estimate

The purpose of this monitoring is to determine how the channel is currently being used by fish and provide baseline information for comparison to future monitoring results. Population estimates will be conducted at permanent transects during the spring and fall of 2003. Care will be taken to insure there are no redds in the sampled transect during

spring sampling. Depending on the results, subsequent sampling will be either in the spring or fall of each year for three years. No fish species should be planted or removed from the project area during this time period.

In order to obtain a regression with acceptable confidence intervals, fish population estimates will be determined by multiple-pass depletion electrofishing methods outlined in Platt et al (1983). Three sample sites will be selected based on habitat typing of the channel. The goal is to represent different habitat types, if they are available in the channel.

Block seines will be placed at the top and bottom of each 50 meter sampling reach. The electrofishing crew will make three passes (or as needed according to protocol-see Appendix A) removing all fish. All fish will be weighed and length measured. Scales and otoliths may be collected from some rainbow trout. Juvenile trout otoliths may be of use in determining the timing of spawning in the Kings River. In addition, a fin will be removed so these fish can be identified in subsequent sampling in the channel to determine if they are residents. Physical parameters of the sampled section including width, depth, velocity, and substrate composition will be measured. Population estimates will be calculated using maximum-likelihood model for each fish species. Additionally, condition factor will be calculated and a length frequency analysis completed.

Channel Morphology

The constructed channel needs to have the basic physical parameters measured to determine the current amount of habitat available for the different life stages. This should include width, depth, length, velocities, substrate composition, percent instream cover, percent overhead cover. Additionally, the flow and temperature regime need to be monitored during the study period.

Physical parameters of the cross sectional profile would be surveyed using a minimum of 30 random transects and wherever there are obvious changes in channel morphology. The longitudinal profile of the thalwag will be surveyed using a survey level and stadia rod. Equipment needed to measure the profiles are a level, stadia rod, measuring tape, flow meter, substrate sieves, densitometer, and a random number table. Additionally, the EPA has a physical habitat quality scoring criteria which will be used to score differences between the constructed channel and the adjacent river section (Appendix B).

Flow and Velocity

Flow in the channel needs to estimated and recorded. A staff gauge should be installed near the notched weir at the lower end of the channel. The weir would be surveyed and a channel rating curve drawn. This rating curve would be corrected by field measurements as per standard USGS methods outlined in Water Supply Paper 2175: Measurement and Computation of Streamflow. The alternative method would be to modify the weir to dimensions to which standard weir equations can be applied (USGS WSP 2175).

Water Temperature

At low flows during either extreme cold or hot weather, a significant difference may exist in regard to stream temperatures. Some gravel projects have cooled water temperatures by moving through the substrate as opposed to over the top of the substrate, exposed to solar radiation. Others have warmed the water by diverting water and exposing it to greater solar radiation effects. Temperature monitoring would be conducted by two temperature loggers located at the top and bottom of the project and at a reference site in the main channel near the bottom. Analysis would include comparing the temperature between the upper and lower units as well as river reference to determine if the project has influence the water temperature.

Macroinvertebrates

Bioassessment techniques are often used as a measure of aquatic health without specifying a particular limiting factor such as water quality or habitat quality. If there is low diversity and abundance of invertebrates, limiting factors are present. If there is high diversity and abundance of invertebrates, fewer limiting factors are present. The CDFG (1999) Water Pollution Control Lab has developed the California Stream Bioassessment Procedure (CSBP), which will be used to compare sites within the project area to control sites in the main channel. Two sites within the project area and two control sites adjacent to the project will be sampled according to the point source CSBP professional protocol. Samples will be either sent to a certified lab or sorted by project personnel, depending on if lab funding is available. Field equipment needed is a measuring tape, stopwatch, kick net, tweezers, hand lens, and specimen jars with alcohol. This task needs to be done only once to determine if there significant differences in the project area.

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Appendix G

News Releases

KINGS RIVER FISHERIES MANAGEMENT PROGRAM

Joining together to improve the Kings River fisheries.

October 14, 2002

N E W S R E L E A S E

FOR IMMEDIATE RELEASE

For More Information, Please Contact:

Tim O'Halloran, Kings River Water Association, 266-0767
Dave Orth, Kings River Conservation District 237-5567
Bill Loudermilk, California Department of Fish and Game, 243-4005
Mickey Powell, Public Advisory Group, 734-7251

KINGS RIVER FISHERIES MANAGEMENT PROJECT TO IMPROVE TROUT HABITAT

To enhance the trout fishery in the Kings River, the Kings River Fisheries Management Program partners, which includes the Kings River Conservation District, Kings River Water Association, California Department of Fish and Game and the Public Advisory Group, are launching today (October 14) a project to improve trout habitat by strategically placing boulders in several locations in the Kings River below Pine Flat Dam near Piedra.

Approximately 800 large granite boulders, some up to five feet in diameter, will be placed at eight sites in the river. The majority of the boulders will be placed in clusters of three or four near the riverbank at the high water mark. That placement will create low velocity habitat for newly hatched fry and juvenile trout during high river flows. A few clusters will be placed at mid-channel to enhance habitat for adult fish.

"The concept behind boulder placement projects is to enhance habitat by modifying streamflow velocity, creating calm areas, and recruiting spawning gravel downstream of the boulders," said KRWA engineer Steve Haugen. The boulders placed over the next six days will also provide refuge from predators and increase habitat for insects, which serve as food for the fish.

"Boulder placement is a proven, effective method of improving instream habitat, furnishing trout with needed cover during low-flow periods as well as refuge from extreme water velocities at higher flow conditions," said KRCD biologist, Jeff Halstead. "Strategic placement of boulders increase the areas for spawning and rearing of trout."

The boulder placement project is among many activities being undertaken under the Kings River Fisheries Management Program, which was established May 28, 1999, by the Kings River Conservation District, Kings River Water Association and California Department of Fish and Game. The Fisheries Management Program is designed to enhance the broad range of fishery resources of the Kings River and Pine Flat Reservoir.

# # #

To make arrangements for coverage at the sites or to request electronic photos, please contact Cristel Tufenkjian at KRCD, 237-5567.

Tim O'Halloran
Executive Officer
559.266.0767

Melissa Goliti
Secretary
559.237.5567

KRWA
Kings River Water Association

KINGS RIVER CONSERVATION DISTRICT · Formed 1951 ·

RESOURCES AGENCY CALIFORNIA DEPARTMENT FISH & GAME

Executive Policy Committee

Tim O'Halloran, KRWA
David Orth, KRCD
Bill Loudermilk, CDFG

Tim O'Halloran
Executive Officer
559.266.0767

Melissa Goliti
Secretary
559.237.5567

September 30, 2002

N E W S R E L E A S E

FOR IMMEDIATE RELEASE

For More Information, Please Contact:
Tim O'Halloran, Kings River Water Association, 266-0767
Dave Orth, Kings River Conservation District 237-5567
Bill Loudermilk, California Department of Fish and Game, 243-4005
Mickey Powell, Public Advisory Group, 734-7251

GRAVEL PLACEMENT AIDS KINGS RIVER FISH SPAWNING

The Kings River's fishery habitat in the Fresno County foothills near Piedra will get a boost beginning October 2 as workers begin spreading gravel to enhance spawning habitat within the river channel.

A total of 2,110 tons of gravel will be divided between three locations in the river downstream from Pine Flat Dam as part of the Kings River Fisheries Management Program. Partners in the three-year-old program are Kings River Conservation District (KRCD), Kings River Water Association (KRWA), California Department of Fish and Game (CDFG) and the Public Advisory Group.

"Addition of spawning gravel will increase spawning habitat available for trout in the river below Pine Flat Dam," said CDFG biologist Randy Kelly. "Addition of spawning gravel in the lower river system will also enhance the habitat for aquatic insects."

The river will be put to work in moving the newly placed gravel downstream. "We will be placing gravel strategically in locations that have high water velocities," KRCD engineer Scott Redelfs, said. "The river itself will distribute the gravel when high flows occur." Construction of Pine Flat Dam a half century ago blocked the natural downstream movement of gravel from the higher mountains.

Gravel will be placed just downstream from the U.S. Army Corps of Engineers Bridge below Pine Flat Dam as well as near the Choinumni Park fishing access above the confluence of Mill Creek. A third site will be downstream from Winton Park.

Heavy equipment will be used to deliver gravel and place it in the streambed. KRCD engineers and biologists are supervising the work. The project is being conducted at this time because the Kings River's irrigation season has concluded and flows are low enough to facilitate construction. All necessary permits for the channel work have been obtained.

The cooperative, consensus-based Kings River Fisheries Management Program is undertaking numerous projects and studies aimed at protecting and enhancing Kings River fish and their habitat. The gravel project is among several activities identified in the Program's current five-year plan that are scheduled to be constructed over the next five weeks.

# # #

To make arrangements for coverage at the sites or to request electronic photos, please contact Cristel Tufenkjian at KRCD, 237-5567.

KINGS RIVER FISHERIES MANAGEMENT PROGRAM

Joining together to improve the Kings River fisheries.

October 7, 2002

N E W S R E L E A S E

FOR IMMEDIATE RELEASE

For More Information, Please Contact:

Tim O'Halloran, Kings River Water Association, 266-0767
Dave Orth, Kings River Conservation District 237-5567
Bill Loudermilk, California Department of Fish and Game, 243-4005
Mickey Powell, Public Advisory Group, 734-7251

The Kings River Fisheries Management Program will be giving nature a hand beginning October 7 when work begins on the latest in a series of habitat enhancement projects in the Kings River's fishery habitat in the Fresno County foothills near Piedra.

Workers will begin ripping the Kings River's hardened channel bed at several locations as well as creating jetties and constructing small coves along the river's banks. The pilot projects are being undertaken by the Kings River Fisheries Management Program and its three partners, the Kings River Conservation District (KRCD), Kings River Water Association (KRWA) and California Department of Fish and Game.

"We will be studying and monitoring construction techniques and biological responses," said Assistant Kings River Watermaster Steve Haugen of KRWA.

Coupled with another soon-to-begin project that will result in over 800 boulders being placed in the river, the channel ripping will expose spawning gravel buried beneath the river's armored streambed. Only a week ago, the Kings River Fisheries Management Program placed spawning gravel in three channel locations.

"We will be able to make use of cobblestones and other materials ripped from the channel to create jetties that will result in calm habitat for young fish," said KRCD biologist Jeff Halstead. "This project will have numerous fishery benefits."

All of the work is toward creating and enhancing rearing habitat for juvenile fish as well as providing cover, resting areas, feeding areas and spawning sites for adult fish. The projects are also designed to increase microhabitats for aquatic insects.

The cooperative, consensus-based Kings River Fisheries Management Program is managing many other projects and studies aimed at protecting and enhancing Kings River fish habitat. The current projects are all included in the Program's current five-year plan.

# # #

To make arrangements for coverage at the sites or to request electronic photos, please contact Cristel Tufenkjian at KRCD, 237-5567.

Tim O'Halloran
Executive Officer
559.266.0767

Melissa Goliti
Secretary
559.237.5567